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COFFEE.

Whether or not coffee is destined again to become one of the great staples of Ceylon and other parts of the East, renewed interest is certainly being taken in the product due principally to the advent of Robusta, a species indigenous to Uganda and the Belgian Congo and introduced into Java about the year 1900 whence it has spread to other eastern countries. It has been said that if ever the East should seriously take up coffee planting again it would kill the plantations of Brazil because of the abundance of cheap labour it can command. The labour position of the great planting countries of Asia is undoubtedly very strong compared with that of America or of Africa, and this must always tell heavily in its favour, but the quality of the product produced is also a determining factor. Consumers would not put up with low grade coffee from the East, however cheap, if they could obtain high grade from Brazil at a moderate price, though of course there would always be a market for the inferior product subject, however, to depression if it were produced in great quantity.

The principal characteristics of Robusta coffee are, as is generally well known, earliness, prolificness and disease-resisting power. In favourable situations it comes into bearing within two years from seed and is one of the heaviest, if not the heaviest, yielders now in cultivation. It suffers from leaf disease in the native gardens of Uganda, but in the East it has hitherto enjoyed comparative immunity, especially under light shade. Robusta coffee is suited to low and medium elevations and does not appear to be a mountain coffee like Arabian. In

the Government Stock Gardens at Colombo (sea level) 75 trees planted on a plot of poor sandy soil are now, though not yet two years old, fruiting well. At Peradeniya (1,600 ft.) seedlings of Robusta planted in 1910 under *Leucœna glauca* shade bore a small crop of berries in 1913. The shade was allowed to get a little too dense and this no doubt checked flowering.

Against the heavy yielding properties of Robusta coffee must be put the fact that it commands a lower price in the market than Arabian, and for that reason may ultimately come to be rejected as a staple. The door may not be finally closed to Arabian, which it is now found does not suffer so much from disease when grown under light shade as when fuller exposed. *C. arabica* could no doubt be rendered more immune by crossing with an immune species, though a difficulty is here met with inasmuch as there is as far as is yet known no immune species in cultivation equal in quality to Arabian, and hence a cross would probably give us a bean of inferior flavour. Many hybrids have been produced. In the Royal Botanic Gardens, Peradeniya, there are several plants of a cross between Arabian and Liberian, but they show variation in type. This is inevitable with new crosses until the type tree has been selected and bred from till the strain is fixed, a process that would last through several generations. Disease-resisting power and flavour should be the principal qualities sought for when selecting the type trees. At the Experiment Station, Peradeniya, there is another hybrid introduced from Paris about the year 1904. It bears heavily and has not suffered permanently from *Hemeleia* though growing without shade. Some beans were sent home in March last for a report on their commercial value and the following has now been received from the Imperial Institute: "The coffee as received was submitted for valuation to brokers, who reported that the sample consisted of parchment coffee which would have been improved by more careful washing. They valued the product, after husking, at 43*s.* per cwt., and stated that it would sell in competition with 'Robusta' coffee, the Java variety of which is now worth from 46*s.* to 49*s.* per cwt. (June 1915) for washed beans of good quality." The average price of Mysore fair to good bold at the time was 78 to 87 shillings. The report also states that the beans "differ considerably in

Photo by H. F. Macmillan.

1. Liberian Coffee. 2. Coffea Stenophylla. 3. Coffea Robusta.
In Royal Botanic Gardens, Peradeniya.

Photo by H. F. Macmillan.

HYBRID COFFEE
At the Experiment Station, Peradeniya.

composition from the average raw coffees of commerce. The amount of caffeine present (1·76 per cent.) is much above the average, the normal quantity in ordinary coffee being from 1·0 to 1·5 per cent., and the maximum figure recorded 1·8 per cent. On the other hand the percentage of crude fibre (12·6) is exceptionally low, the usual amount being from 20 to 30 per cent. and the lowest figure for a large number of analyses 16·6 per cent. The amounts of protein, ash, and starch are normal, but the percentage of fat is decidedly low."

Bushes of the second generation of this hybrid planted in 1908 first came into bearing in 1912. They were planted without shade, and in 1913 and 1914 suffered severely from green and brown scale and leaf disease, some of them dying. With cultivation, manuring and mulching the survivors revived and are now bearing heavy crops as will be observed from the photograph of one of them reproduced. It is an example of what can be accomplished by cultivation. This hybrid would appear to be a cross between Arabian and Liberian, but some of the bushes approximate in appearance to the one and some to the other. All are heavy croppers. Type trees are being selected for testing flavour and for reproduction on the assumption that those more closely resembling the Arabian in appearance will probably do so also in flavour.

Some fine specimens of *C. stenophylla* exist at Peradeniya, introduced in 1894. They are about 25 feet high, and though they have been allowed practically to run wild under rather heavy shade yet they bear good crops annually. In the Kew Bulletin of 1893 *C. stenophylla* is spoken of as being sold by a French dealer as 'best mocha' at 4 francs 50 centimes a lb. Stenophylla is a possibility for a cross with Arabica. At Buitenzorg, where hybridization has been carried out on a considerable scale, Stenophylla has been crossed with Liberica but not apparently with Arabica.

There are considerable areas in the uplands of Ceylon too high for rubber and not wet enough for tea, as for example parts of the Uva patnas, that could come under coffee if the problem of immunity *cum* flavour could be solved. We believe we are correct in saying that in the coffee days plantations in Ceylon were not shaded; but, as has been stated, it is now recognised that light shade affords protection from leaf disease.

R. N. L.

UGANDA COFFEE.

The history of the coffees grown in Uganda is as follows :—

The occurrence of coffee in Uganda is first mentioned by SPEKE in his NILE JOURNAL, Appendix p. 636, where he states that coffee "M'wanee" is cultivated in considerable quantities on and about the equator. The trees grow 10-12 ft. high, their boughing branches affording shade.

STUHLMANN, in his account of the Uganda people in Emin Pasha's African Expedition p. 179, states that nearly every native banana plantation has its solitary coffee tree.

He also expresses the opinion (p. 720) that the coffee plants of the banana groves of Bukoba, on the German East African border of Uganda, appear to be indigenous ; at least not introduced by either Arabs or Europeans. The coffee referred to in this paragraph is undoubtedly the "Bukoba" coffee which was later described by FROEHNER as *Coffea arabica* var. *Stuhlmannii*, and which, from the examination of the type kindly lent to Kew by PROFESSOR ENGLER, appears to be little more than a form of *C. robusta*. Linden. This variety was afterwards raised to specific rank by ZIMMERMANN as *C. bukobensis*.

According to SIR HARRY JOHNSTON (UGANDA PROTECTORATE, vol. i. p. 288) the coffee plant "whether originally introduced or not from Abyssinia is at any rate native now in a semi wild form to the better forested regions of the Uganda Protectorate, its berries producing coffee of excellent flavour."

Again in vol ii., p. 674, speaking of the Bantu people, SIR HARRY says that the coffee tree is probably indigenous to the forests of Uganda and the neighbouring islands in Lake Victoria.

In 1902 J. MAHON communicated to Kew dried specimens of "the common coffee of the country, collected from bushes 20 ft. high in a deserted native garden," and other specimens grown in the Entebbe Botanic Gardens from a seedling sent from Kew in 1901. The plants are practically identical, except that the ones from the native garden have smaller leaves, as might be expected from a neglected bush, and may without doubt be referred to *C. robusta*, Linden.

It seems clear, therefore, that the wild coffee of Uganda which is found in native gardens and plantations is *Coffea robusta*, Linden, a species which, as DE WILDEMAN has already suggested, may be merely a variety or local race of *C. canephore*, Pierre, which was originally described from specimens from the Gaboon.

To sum up, therefore, we have the following synonymy :—

Coffea arabica, var. *Stuhlmannii*, FROEHNER = *C. bukobensis*, ZIMMERMANN = *C. robusta*, LINDEN = *C. canephora*. PIERRE, forma.—KEW BULLETIN.

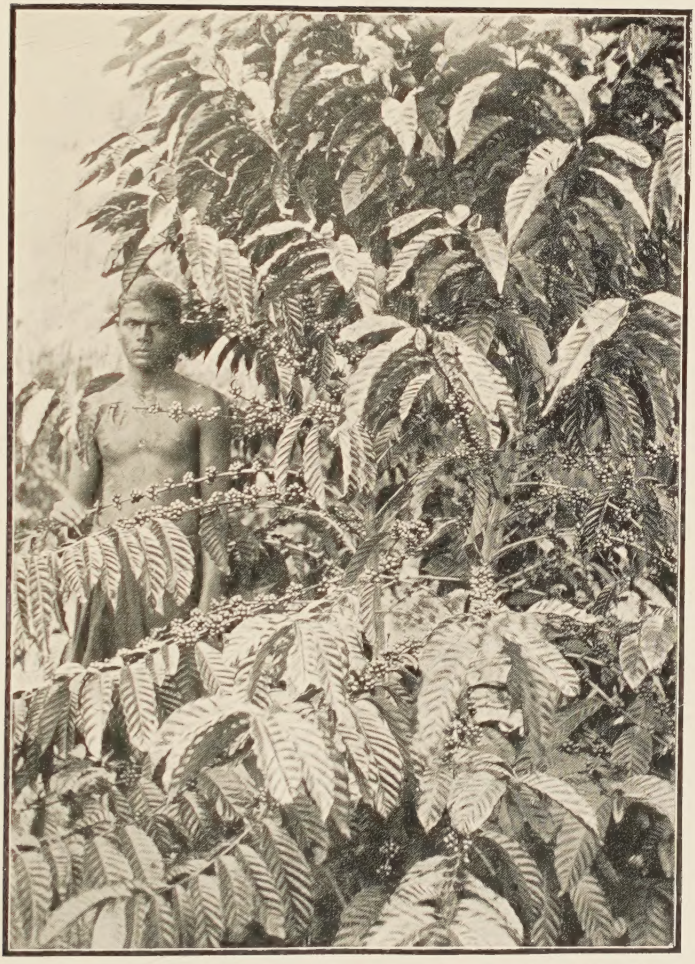

Photo by H. F. Macmillan.

COFFEA ROBUSTA.

At the Experiment Station, Peradeniya; received from Java as Uganda Coffee, apparently the same as Robusta coffee.

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COCONUTS.

COCONUTS IN THE DUTCH EAST INDIES.

A few remarks about the coconut in these Islands (based on personal experience) may prove of interest. The local name for the nut is "Noere," and the tree is "Noere Tenne." There are at least eight different sorts to be found here, the red and green varieties being most common. Then come the small nuts, one being round as a ball with large meat content, the other cigar shaped. There is also a variety which bears early and forms a dwarf tree, which may be the King Coconut. A nut which is called in Malay Klapa Kenarie (locally Noere Minuk) is also fairly common, though I doubt whether it is a distinct variety. The meat or flesh is very soft and is of no value as copra locally, owing to the difficulty of separating the meat from the shell and the great shrinkage which takes place in drying—though the flesh is said to be very rich in oil. Traders here assert that three hundred nuts go to one picul copra (picul=133$\frac{1}{3}$ lb.) but by choosing the red and green nuts only two hundred and fifty are necessary. Nearly all copra bought from the natives is smoked, as they have no inducement to sun-dry it. Tapping the trees for toddy (toeak) is extensively practised, though the manufacture of arrack (sopi) therefrom is forbidden by the Government. The natives do not consider all trees to be suitable for tapping, and often reject several before finding one that gives a good flow of juice. The method employed is practically the same as that detailed in the Manual of Coconuts, but chillies are added to the toddy to give it a "bite." I have seen no traces of disease here, but have remarked several trees which exuded a transparent gum. The black beetle is found in large numbers, but only an occasional tree shows the well-known clipped leaf. A small white cockatoo is regarded as being very destructive to half ripe fruit. According to the natives this bird opens the shell and eats its fill, and then calls the red parrot to finish the remainder. I have seen numbers of nuts punctured with a 1$\frac{1}{2}$ inch hole, and have also seen both birds eating the meat, but am not prepared to assert that the puncture is made by a bird and not by the rats. The edges of the hole present the same appearance as that made by the batjing (small squirrel) in Java, though I believe the latter is not found here. In opening my plantation here, I purchased 15,000 nuts and rejected 2,000 as being unsuitable for planting: the remaining 13,000 were steeped in sea-water and immediately stored in a dark godown for one month. They were then taken to the nurseries and planted horizontally six inches by twelve between the nuts with a pathway between every three rows. The nuts were planted to half their depth in the soil and covered with a four inch layer of dry grass. When taken from the godown about 50 per cent. had sprouted, and three months from date of plucking all unsprouted nuts were turned into copra, making total rejections 4,000. At three months I therefore had 11,000 plants and had reduced the purchase price, as the copra was sold at a good profit. At the end of six months I rejected 1,000 backward and ailing plants, and had lost up to that

time 500 plants through various causes. The remaining 9,500 plants received a pint of brackish water daily for six months and at the end of one year many plants were over two meters in height by actual measurement, and in no part of the nursery could a man's head be seen above the plants. There were a few exceptions, perhaps 5 per cent., where the plants for some reason formed the crown leaves without reaching the uniform height of their neighbours but on the contrary had a very strong butt. The diameter at the base of plants was always 1½ inch and often exceeded 2 inches. No manure was applied to the nurseries but they were kept clean weeded. In transplanting the plants to the field I left every third row standing, and these will be planted out as two-year-old plants. A great deal of damage was done to the roots of the young plants, and about three months cessation of growth resulted, but as far as I can judge at present no permanent harm resulted. I may mention that out of 11,000 sprouted nuts there were seven having two sprouts and one having three sprouts. These are all doing well but are more backward than the others. In transplanting I found large numbers of black beetle in all stages, but not one instance of its having attacked the plants. It seemed merely to have used the moist cool ground under the nuts and grass as a breeding place. The four spotted weevil (mentioned by a Philippine authority as attacking only dead trees) was fairly common when the trees were from twelve to eighteen inches high, large numbers of the leaves being broken where the weevil had made its entrance and subsequent excavations; but the plants seemed to resist the attack better as they grew in strength. I caught many weevils by simply slitting the leaf stalk with a knife point; others were found with the head protruding from the entrance to the tunnel. The tunnelling was done usually towards the base and extended to a maximum length of 5 inches, being partly filled with fibrous matter. I never saw larvæ in the tunnels, which vary in diameter from 3 mm. to 5. mm., but of the 500 dead plants alluded to above the majority upon being opened were found to have numbers of small white grubs 10 mm. in length in the growing point and base of the stalk, but no weevils were to be seen.

A. W. A.

COCONUTS IN THE SOLOMON ISLANDS.

Coconut planting on a commercial and scientific basis was first started in the group about fourteen years ago by CAPTAIN SVENSEN, a man who had a large experience of the Pacific Islands and is now reaping the benefit of his energy and foresight. Since then planting has been proceeding at an ever-increasing rate, and to-day there are about 25,000 acres under coconuts on plantations owned by white men. Soil and climatic conditions are so uniquely favourable to the growth of the coconut palm that it comes into bearing at a much earlier date than in Ceylon or India. Trees five years old are to be seen bearing prolifically. On the writer's (FRED. GOULD) last visit to the Solomons he saw a tree not six years old carrying considerably over 300 nuts, and this is by no means a record for these islands.

The soil is all of a volcanic origin : mainly rich, deep alluvial, of quite exceptional fertility, mixed with a coral limestone, very suitable for coconut cultivation. Being virgin scrub country it is naturally in splendid physical condition, and exceedingly high in available nitrogen, phosphoric acid, potash and lime, so that it should keep its fertility for a long period of years. The luxuriance of the vegetation which grows right down to the water's edge is an excellent indication of the amount of plant food which the soil contains. The old idea that the coconut thrives best in sandy soil is quite exploded in the Solomons. It has been abundantly proved that in the heavier, richer soils the tree puts on a much more vigorous growth, comes into bearing earlier and yields a heavier crop.—The Louisiana Planter and Sugar Manufacturer.

TO GET RID OF RATS.

The Journal of the Jamaica Agricultural Society gives the experience of an old cocoa planter whose smoking-out process is said to have effectually rid his estate of rats.

He built one or more woodfires ready for lighting on the windward side. At dusk with a steady breeze blowing he lighted the fires and threw on them a number of smoke-forming substances (e.g. sulphur, incense, etc.) together with a quart of bird's eye pepper.

In his own experience he says that it is seven years since he tried this remedy and the rats have not returned. Human beings are advised to keep out of the track of the smoke.

The Pastoral Review recommends that if a few handfuls of sulphur be rubbed over the bags in which grain is stored, rats and mice will not touch them.

OIL CONTENT OF SEEDS.

The oil content of seeds as affected by the nutrition of the plant is dealt with in a paper in the Journal of Agricultural Research, Vol. III, No. 3. It is concluded that climate is a more potent factor than soil type in controlling the size of the seed and its oil content, probably because climatic conditions largely regulate those of the soil.

Within ordinary limits the relative fertility of the soil appears to be a minor factor in influencing the size of the seed and its oil content. In fertilizer tests with cotton, the addition of a complete fertilizer to an unproductive soil gave larger seed and a considerably higher percentage of oil. Application of increased quantities of nitrogen did not affect the size of the seed but lowered the percentage of oil. Increasing application of phosphorus or potassium did not affect either character. In pot culture tests with soy beans, the addition of phosphorus did not change the size of the seed, but increased the oil content.—The Agricultural News.

TOBACCO.

TOBACCO GROWING IN QUEENSLAND.

Although the tobacco-plant thrives wherever it is sown in Queensland, or even where it is self-planted, it has been found by experience that it was only in certain districts, in certain classes of soils, and under certain climatic conditions that the most perfect qualities of the leaf can be developed. The districts recommended by the Government for the culture of pipe and cigar tobacco are, for the former, Texas and Inglewood, on the southern border of Queensland, and the coast between Bowen and Cardwell in the north. It may, of course, be discovered later on that there are other districts where this form of agriculture may be pursued with profit. The latter kind of tobacco has thriven in the northern district mentioned, and growers there have realised from £60 to £100 per acre for their crops. Cigar-leaf is exclusively grown in the north. The value of an acre of pipe tobacco may be set down at £30, so that it is obvious that only a small area under intense cultivation is needed to ensure a competence. In 1911, 10,044,399 lb. of manufactured plug and cut tobacco were produced. This required 8,546,726 lb. of leaf, of which no less than 7,339,611 lb. were imported from abroad. To this must be added the weight of manufactured tobacco and cigars also imported, so that over 2,500,000 lb. more must be allowed for. British New Guinea has now entered the field of competition with cheap coloured labour. In 1912 eighteen tons of leaf were made into cigars, etc., in that country, and the reduced cost of culture and manufacture ensures a good market in Australia. Under the Commonwealth Counties Act, high grade cigar-leaf receives a bounty of 2*d*. per lb. for five years if grown under certain conditions.—United Empire.

SELECTION AND PREPARATION OF TOBACCO LAND.

THE NURSERY.

The nursery should be located on rich, well-drained land. It should be covered over with a layer of coconut husks or waste wood and burned. This renders some of the potash salts of the ground more available for the plant food, destroys insect eggs, and kills the grass and weed seeds. The ashes should be dug into the soil as they are good for manure and also prevent the soil from becoming so hard. After digging, the soil should be put into a finely pulverised condition, levelled off, provided with good drains to prevent water from standing on the nursery, and the beds are ready for manuring.

It is better to apply well rotten manures, as they are more cooling and are also less likely to contain weed seeds that would produce weeds to crowd the growth of the tobacco plants. The manure should be worked into the surface soil and the surface made smooth.

The middle of October is the best time for sowing the nurseries in the Jaffna District. The seeds should be winnowed in a gentle breeze to get out all of the light and faulty ones. One teaspoonful of seed is enough to sow five square yards of nursery. They must be mixed with a large pan of ashes or other fine material to enable the sower to distribute them evenly over the nursery. Pressing the surface of the soil with a board, or by trampling, will cover the seed sufficiently deep.

All *weeds*, bushes, etc., should be removed from around the nursery, as they make an attractive hiding place for insects which would feed upon the young plants. For the same reason the shade should be erected *over* the nursery instead of being placed upon it.

When rains are infrequent, the nursery should be watered in the early morning or late evening, by sprinkling. If the water is poured on, it will wash up some of the small plants.

If the plants come up too thick, some of them should be plucked out to prevent the remaining ones from producing a weak spindling growth. It is very important to secure sturdy seedlings with a large, short stem and a good root system. Such plants not only live better when transplanted, but grow better and produce better tobacco.

THE PLANTATION.

Virgin soil produces the best quality of tobacco. The ground should be ploughed deep, at the beginning of rainy season, and sowed to sunn hemp or other green manure crop, to be turned under just prior to preparing the land for transplanting the tobacco. This last ploughing should be only moderately deep as it is better to leave the subsoil in a firm condition. The ground should then be manured broadcast. The manure should be thoroughly mixed with the surface soil by ploughing or harrowing, and the ground put in a well pulverised condition before transplanting. Assuming that sturdy plants have been secured from the nursery, it is not necessary to shade the plants if transplanting is done during the months of December or January, before the sun gets extremely hot. It is best to do the transplanting late in the afternoon. Care should be taken not to double back the roots of the seedlings in the operation of transplanting. A shallow hole should be made by the side of the plant and filled with water. As soon as the water has settled in the hole, the earth should be lightly replaced. By this method it is only necessary to water the young plants once every three or four days. Do not be alarmed if the plants wither a bit when they are set out. As long as the stems do not become shrivelled, the plant is not harmed.

It is a bad plan to pen cattle or sheep on land as a method of manuring, during wet weather, as the tramping of the cattle ruins the physical properties of the soil.

B. F. S.

THE MARKETING OF NYASALAND TOBACCO IN LONDON.

The quantities of unmanufactured tobacco remaining in bonded warehouses or entered to be warehoused at the chief bonding ports in the United Kingdom were as follows on December 31st, 1911 and 1912 :—

	1911. lb.	1912. lb.
London ...	38,842,508 ...	41,031,606
Liverpool ...	107,605,207 ...	112,166,858
Bristol ...	26,069,739 ...	25,850,903
Leith ...	1,426,062 ...	1,615,755
Glasgow ...	8,794,991 ...	10,598,038
Dublin ...	1,120,295 ...	1,014,628
Belfast ...	9,132,339 ...	11,778,634

It is clear from these figures that there should be a good market for the better grades of Nyasaland tobacco in provincial ports of the United Kingdom, but the results of enquiries show that it will be just as difficult to dispose of the lower grades there as it is in London.

It is however worth while to consider plans for avoiding the heavy dock and other charges in London, but representations to the Port of London authority are not likely to succeed unless action were taken by the tobacco trade of this country as a whole. It is understood that the attempts already made to sell Nyasaland tobacco in provincial ports of the United Kingdom have not been very successful, but this may be due to the fact that only low grades have been offered there.

The following plan may be worth consideration :—The planters in Nyasaland might combine to start a central grading and packing warehouse in Nyasaland, or perhaps one of the large buying houses in the country might undertake this work. The planters might send their cured tobacco to this warehouse, receiving an advance, the amount of which would depend on the quantity and quality of the tobacco deposited.

The tobacco would be graded and packed at the warehouse under expert supervision, and the manager would submit to manufacturers in the United Kingdom typical samples of the season's grades and ask for direct orders.

If this system were successful the tobacco could be shipped direct to the port nearest to the manufacturer's factory.

There are several objections to this plan ; thus, manufacturers like to buy on dock samples, and it might be difficult to overcome this preference, at any rate at first. Again it is stated that the quality of the tobacco produced in Nyasaland varies during the season, so that the grades would change during the season. Further, it seems likely that there may be advantages in having a large stock of Nyasaland tobacco awaiting sale in the United Kingdom, as it is then on the spot to meet any sudden demand. The plan would, however, have some advantages and may be worth consideration.

It seems clear that there is no prospect of arranging for pubilc sales of tobacco in the United Kingdom, so that the question of avoiding or reducing the heavy charges for dock and warehouse accommodation, now paid in

London, resolves itself into either selling direct to manufacturers in the provinces as suggested above, or in interesting provincial merchants and brokers in the sale of Nyasaland tobacco to manufacturers. The third possibility, viz., the general improvement in the quality of Nyasaland tobacco so that it can be sold more quickly and at higher prices, when these admittedly high charges would bear less heavily upon it, has been referred to already.

QUALITY OF NYASALAND TOBACCO.

From figures supplied to the Imperial Institute it appears that in the season 1912-13, the percentage proportions of the various grades of Nyasaland tobacco marketed were as follows :—

First grade	3·18	...	Fourth grade		28·6
Second ,,	14·69	...	Fifth ,,		20·5
Third ,,	22·06	...	Sixth ,,		10·9

It is clear from these figures that a very large proportion of Nyasaland tobacco placed on the English market in 1913 was of very low grade, and it is this low grade tobacco which is the source of all the present trouble. The tobacco received this year from Nyasaland is said to contain less low grade material. There is a very small market in this country for anything but the better grades of the Virginian types of tobacco, and therefore low grade brown and nondescript tobaccos are extremely difficult to sell, and when they are sold they fetch very low prices. That is the reason why Nyasaland tobacco sometimes has to lie in the London warehouses for years before it is sold. As this is the crux of the whole question the Imperial Institute has made enquiries on the point from manufacturers, brokers and merchants in London, and the following is a selection from the opinions expressed :—

MANUFACTURERS.

(1) "We are constant users of the Nyasaland tobacco, but we always buy from London or Liverpool dock sample, and will be pleased at any time to consider any such sample sent us, provided they are of good quality."

(2) "Nyasaland tobacco is often of dark colour, and in this respect it was especially bad last season (1912-13 crop). That is the chief reason why it sold so badly. This year's crop is better. Nyasaland tobacco will not absorb much water, and therefore, unless cheap, is not economical to use. Irish and Canadian tobaccos are better in this respect. Both these types are now being produced of good quality."

This firm already uses a fair quantity of Nyasaland tobacco and is anxious to use more if the planters will produce what is wanted, viz., "bright" tobacco. The Admiralty already buy a good deal of Nyasaland tobacco. Manufacturers in the United Kingdom have no special interest in, or prejudice in favour of, American tobacco, and other things being equal they will buy Colonial tobacco in preference to that from other sources, including America.

BROKERS.

"We have had considerable experience in the sale of Nyasaland tobacco during the last few years.

"With regard to the complaint that the tobacco lies a long time in warehouses here, and then realises low prices, this may be justified when shipments consist of low and mixed grades, as for these there is a very small sale.

"With better grade tobacco, i.e., good "bright" and "semi-bright" leaf, there is as a rule a fairly quick sale, at good market prices, and as this better grade of tobacco is coming more into favour with manufacturers here, there is a steady demand for it, which demand will, we feel sure, greatly increase, so that it behoves planters to do their best to improve the quality of their crops.

"Speaking for ourselves, we consider that, taking Nyasaland tobacco on its merits, full value has been obtained with all sales, especially as this growth was, for some considerable period, looked upon with disfavour by the majority of manufacturers."

MERCHANTS.

(1) "My firm, from the very commencement, has taken a great interest in this Nyasaland tobacco, and was largely instrumental in introducing it to the British market. With regard to the complaints mentioned in your letter about the difficulty of selling the tobacco in our market, and the poor prices realised, I can state as follows :—

"The principal demand in our market is for 'bright' tobacco, which sells quickly and realises a good price. 'Brown' and 'nondescript' tobaccos on the other hand, such as predominated principally in the large crop of 1912-13, have only a limited sale and command a poor price. The complaints in question are no doubt largely due to the poorness of this crop, which was a most troublesome and difficult one to handle. The efforts of planters should therefore be directed to the production of a 'bright' tobacco, a small crop of which will pay better than a large one of 'brown' and 'nondescript' tobacco.

"Care should also be taken to avoid shipping tobacco late in the season, as it is likely to be held up on the way to the coast through the low state of the river, and owing to this cause very often too brittle to handle. If it is possible for the Nyasaland planters to act as suggested above they will, I believe, have more satisfactory results in the future.

(2) "We note your remarks with reference to the complaint made by Nyasaland planters with respect to their shipments of tobacco to this side, and in reply to your enquiry as to whether these complaints are justified, and also if we can put forward any suggestion to overcome the difficulty, we would point out that the trouble is caused purely by the inferior quality of the majority of the tobacco that arrives here from Nyasaland. Buyers on this side will not even trouble to look at the dark leaf which comprises the larger proportion of most of the shipments.

"Therefore, it appears to us that the only permanent remedy that can be arrived at is for the planters to endeavour to improve the quality of the stuff sent here, which will result in their finding a ready sale for their produce, as good, fine, light tobacco of all growths is quite easy to dispose of to buyers."

It will be seen that these firms are unanimous in stating that it is only the lower dark coloured grades of Nyasaland tobacco which do not sell readily in the market, and that if larger quantities of the better grades could be produced the sales of Nyasaland tobacco would increase rapidly.

The question for the planters is therefore that of augmenting the production of first grade "bright" or "semi-bright" tobacco. Opinions differ as to the cause of the large proportion of brown, dark and nondescript tobaccos

in the Nyasaland output. It seems likely that the soil on which the tobacco is grown has a good deal to do with this matter. The ideal soil for the production of "bright" tobacco is a rather sandy loam, and it seems possible that much of the soil on which tobacco is grown in Nyasaland is too rich to yield first grade tobacco of the Virginian type. This is a problem which can only be solved by co-operation between planters and the Department of Agriculture, and it would be of great assistance if the Department of Agriculture could get from planters data which would enable it to determine the proportion of first grade tobacco obtainable from different types of soil in Nyasaland.

Another factor which favours the production of "brown" and "nondescript" tobacco is excessive humidity of the atmosphere and a high rainfall.

Even in the best tobacco-growing districts of the United States there is always some "brown" and "nondescript" tobacco in the crop, and this is usually attributed to the presence of unripe or over-ripe leaves. The proportion of low-grade tobacco due to this cause is, however, usually small, and though some of the low-grade produce in the Nyasaland output is undoubtedly due to this cause, this certainly does not account for the bulk of it.

If the investigation suggested above proves that the cause of the high proportion of dark coloured tobacco is due to over-richness of soil and excessive humidity, it may become necessary to restrict tobacco cultivation to certain areas, or to produce by selection a tobacco which will give a "bright" crop even under what are now regarded as unsuitable soil and climatic conditions. Nyasaland has already successfully evolved a good local type of cotton, and there seems to be no reason why a similar solution should not be found for this difficulty in tobacco cultivation.

The other complaint made by manufacturers is that Nyasaland tobacco will not absorb as much moisture as American tobacco, and is therefore less economical to use. This is not such a serious matter at the moment as the question of the dark colour of the tobacco referred to above, but it is of great importance to the future of Nyasaland tobacco. The defect is probably due to a difference in the texture of Nyasaland tobacco as compared with the American product, but nothing definite as to the cause can be suggested at present. The Imperial Institute proposes to investigate the question, and a report on the subject will be furnished in due course.—Supplement to the Nyasaland Government Gazette.

SEED-SELECTION AND BEDS.

Last month we discussed soils, and now come to the important item of selecting and raising seeds. To get the right seed you must go not only to the right plant, but to the last word in the particular variety of the plant that you wish to raise, and even then having got the most suitable plant and the best seed, still go over the latter carefully and see that you use only the best of the best. We believe in most cases that your choice as regards the variety and hence the seed that you wish to select, forces you to consider not only the type you wish to rear, but also the markets that it will probably pay you best to supply. On this point the Orange Judd Company's book* will give

* The Tobacco Leaf, by Killebrew and Myrick; in London of Tropical Life Publishing Department, Price 11*s.* 6*d.*, post free.

you very full information as it devotes many pages to the various kinds of tobacco as well as including tables and details of the numberless varieties that they discuss. If they do not discuss every variety known, then we trust that we may never be compelled to complete the list.

"No step in the culture of tobacco is more important than proper care in the preparation and sowing of the seed beds," this book tells us. "This work cannot be neglected in manner or season without running the risk of making a partial or total failure of the crop. To make good beds is a laborious task, and requires ripe judgment both in the selection of the location, the soil, and in the preparation of the land." Of this more anon. Plants, we believe, have to be carefully acclimatized and so in at least some parts of America, we understand, the rule is not to raise crops from freshly imported seeds, but to let the plants become acclimatized first. As regards KILLEBREW'S book we must own that the plan they propose is not quite clear to us, but as it may be to others we will quote what they say, then give the page to let our readers look it up for themselves. "Some growers of fine cigar wrappers," we are told, "import seed from the best Vuelta districts of Cuba and grow it, as previously described, for four years in succession before saving seed for crop purposes, and thus succeed in raising a uniform article year by year. Crops are never raised from freshly imported seed,* because several years are necessary to thoroughly acclimatize the plant. The idea that Havana seed should be used only for a few years after importation, that it deteriorates, runs out, runs into seed leaf, etc., is disputed by many of the most skilful growers in Connecticut valley, who believe that these results arise more from cross-fertilization than from any other cause. It is true that soil and climate gradually change the size and fragrance of the leaf in the course of a long term of years, but this change does not necessarily lessen the quality of the leaf for wrappers if proper attention is paid to raising and selecting the seed. They believe that the quality, instead of deteriorating, steadily improves under the careful cultivation given to it," (see p. 166-167). "Tobacco," we are told on p. 163, "apparently has a natural inclination to depart from a fixed type and break into sub-varieties, thus adjusting itself to the climate and soil in which it is placed." If, however, in adjusting itself to its new surroundings, it loses or changes even those points which cause it to be preferred over all others, then of course the object of its introduction is not attained.

The seed is, of course, very small—estimates vary in placing the number per ounce at 287,000 up to 389,000 seeds. If all the seeds of a single plant germinated and the plants all thrived, then one plant would supply sufficient seed to plant 250 acres. An average head, says KILLEBREW, contains eighty pods, and each large seed pod when properly fertilized and developed contains about 5,000 seeds. Now 80 × 5,000 = 400,000, so that the above estimates are, to say the least of it, reasonable. The Rhodesian Handbook also calls attention to this (see p. 13) when it tells us: "If all the seeds of a plant were fertile and capable of germination, one ounce of tobacco seed would be sufficient for 300,000 plants. Experience has shown, however, that at least 75 per cent. of the seeds are sterile, and that many of the remainder

* If so, then what becomes of the tobacco raised for the four years as described in previous sentence? Is it thrown away?

will produce only small and unthrifty plants, so that for every 30,000 plants required, it is necessary to allow one ounce of seed. Now 30,000 plants would be sufficient to set from four to seven acres of the Virginia type of tobacco, or two acres of the Turkish and cigar tobaccos." Two or even seven acres are much less than 250 acres, so when buying seed, and let this always be of the very best, care must be taken to ascertain what area of land can be covered per ounce of seed purchased as well as sown.

The present problem of increasing the plant's efficiency is not merely one of nutrition but a problem which touches on the physical basis of life. It consists in an endeavour to adjust the properties of protoplasm to external conditions, and such an endeavour requires the application of research.

In this respect very interesting results have been obtained, the Barbados Agricultural News of May 8 tells us, in regard to the influence of shade upon assimilation. The Florida work in connection with tobacco is probably well known to most persons. The idea orginated from a chance observation that some Sumatra tobacco grown near trees where it had been partially shaded was superior in quality to the rest of the field. Experiments were then begun to produce tobacco under artificial shade. The first method of shading was with lattice work which produced good results, but on account of the ease of erecting, openly woven cotton cloth has replaced the lattice work. After a few years of successful work in Florida, the idea was taken up by other States, and now growing tobacco under shade is an important industry not only in the United States but in South Africa, Java, and other countries. It is of interest to record that this method of cultivation has been tried locally in St. Kitts with highly satisfactory results. The point to bear in mind in connection with this work is that it consists in producing a change in the activity of the plant cells, in a re-adjustment of functions ; and is on a different plane altogether to the influence of soil nutrients.—Tropical Life.

SEAWEED AS MANURE.

Sea weed, which is plentiful on some coasts, forms a cheap and valuable manure.

The composition varies with the variety, but the following may be taken as the approximate analysis :—

Water	80 per cent.	
Organic matter	10—·20	,, ,,
Nitrogen	·3—·73	,, ,,
Potash	·3—1·9	,, ,,
Phosphoric acid	·1— ·5	,, ,,

From the above analysis it will be seen that sea weed is comparable as a manure with farmyard manure, being, however, slightly deficient in phosphates.

It has the advantage of being free from weed seeds.—Journal of Agriculture, Victoria.

RUBBER.

WILD RUBBER AND SELECTION.

Dr. Cramer, of Buitenzorg, in a paper under this title, gives some useful hints to growers on the selection of *Hevea*. This subject, he points out, has been neglected, or at any rate undertaken on wrong lines. The selection of *Hevea* should commence with the seed-bearers, and not be entirely confined to the seeds or the seedlings. According to the author's personal observations of both wild and cultivated trees, considerable variation occurs in the shape and size of the seeds from different examples and also in the productiveness of wild trees, among which "barren" individuals are sometimes found. Dr. Cramer gives reproductions of photographs of a series of seeds from trees of *H. brasiliensis* growing in the same localities in Brazil, which show striking variation in size. The impossibility of determining critical species from seeds alone is evident from the author's remark that "the difference in (seed) characters in *Hevea Randiana* (a closely allied species) and *H. brasiliensis* is less marked than may occur between the seeds of two trees of true *brasiliensis*."

The wild trees observed by Dr. Cramer were all from the lower reaches of Brazilian rivers, which often overflow their banks at high tide; and he suggests an interesting explanation of the cause of marked differences which are shown in adjacent trees in such localities. Frequently seeds may be observed floating down the rivers from the upper reaches, and these become stranded in quiet corners of the banks, where they form a layer on the water. At high tide they are immediately transferred to a considerable distance on the adjoining banks, where they germinate. Therefore many of the trees now growing in the lower reaches of Brazilian rivers are really the direct offspring of upper region types and thus a mixture of the two races has been brought about.

Part 5 of the paper deals with experiments on seedlings and tables and photographs are given showing their relative variation from different stocks.

In part 6, Dr. Cramer points out that, according to the late Dr. Huber, the Tapajoz region of Brazil where Wickham obtained his seeds, is not the place from which the best rubber is at present obtained, and as nearly the whole of the East India plantations have been stocked from seeds gathered in this region, it is therefore assumed that the quality of the rubber is not so good as it might have been had the first seeds been gathered in the Acré district of the up-river regions, i.e., on the Beni and other tributaries of the Upper Madeira and Purús rivers, where the best rubber is at present obtained. There is, however, no indication that this rubber is superior to that which used formerly to be collected in the Tapajoz region.

The question is discussed as to whether this Acré or up-river *Hevea* may be a distinct variety or subspecies of *H. brasiliensis*, as is the general belief in Brazil, and Dr. Cramer is himself inclined to this opinion.

It should be noted that Dr. Cramer's work on Hevea selection so far concerns the character of the seedlings only, and it remains to be seen whether the young plants showing the most vigorous growth will prove to give the greatest yield of latex.

Dr. Cramer's interesting contribution concludes with notes on the practical importance of careful choice of the best producing varieties of other agricultural crops, citing as examples the advantages which have accrued from the introduction of *Cinchona Ledgeriana*, with a bark richer in quinine than the elder *C. officinalis*, the replacement by Assam of the old China tea, and the revival of the coffee cultivation in Java by the advent of *Coffea robusta*.—J. H. in Kew Bulletin.

SOME RUBBER NOTES.

Exports of wild rubber from German East Africa, which in 1910 reached a total of 725,584 pounds, with a value of £145,147, fell off to about half that quantity in the following year, and in 1912, amounted to 379,938 pounds, valued at £59,298. The chief rubber yielding plants native to German East Africa are the *Landolphia Stolzii* and the *Landolphia dondeensis*—the former a vine occurring commonly in the New Langenburg district, north of Lake Nyasa, and the latter a shrubby plant occurring in the southern parts of the Protectorate. Other wild rubber plants are the *Mascarenhasia elastica*, *Landolphia Kirkii*, *Landolphia lucida*, *Clitandra Kilimandjarica* and *Holarrhena microterantha*. The wild rubber exported has been collected chiefly in the forest reserves of Kimboza, Mouha, Uluguru (Morogoro) and Unguru (Bagamoyo). Dar-es-Salaam and Kilwa are both reported as producing good wild rubber in considerable quantities.

The planting industry, on the other hand, has made rapid progress during the last few years, the value of exports of plantation rubber, including gutta percha, rising from £20,798 in 1908, to £362,012 in 1912. The Ceara Rubber tree (*Manihot Glaziovii*) has been most extensively planted, although some attention has been devoted to *Funtumia elastica*, *Hevea brasiliensis* and *Ficus elastica*, the area under these three varieties amounting in 1910-11 to 355 acres, in 1911-12 to 698 acres, and in 1912-13 to 1,035 acres. A small *Landolphia* plantation was also established some years ago at Langenburg. During 1910-11, when the area planted in Ceara rubber had reached a total of 63,222 acres, divided between 248 plantations, the high price of rubber led to severe tapping of the trees, which, with wind storms of some violence, resulted in extensive damage; and this induced hasty extension of the plantation with consequent less thorough cultivation and rise of wages through scarcity of labour. The area under Ceara cultivation had risen in 1911-12 to 81,705 acres, and in 1912-13 to 112,258 acres.

The following table shows the quantity and value of the rubber exports for the year 1911 and 1912.

	1911.		1912.	
	Tons.	Value. £	Tons.	Value. £
Plantation rubber and gutta percha (destination Germany and the United Kingdom)	671	180,480	998	362,012
Wild rubber and gutta percha (destination Germany)	168	58,568	181	59,298

Attempts have been made to improve the economic condition of the industry in this protectorate, mainly by means of less expensive methods of tapping and by utilization of catch crops or of secondary cultures, such as beans and maize.

RUBBER ON THE GOLD COAST.

During the past six years 250,000 Para rubber plants and 1,500,000 seeds, have been distributed by the Government of the British Gold Coast Colony, and many trees have reached the tapping stage. The Government is instructing and encouraging the natives in improved methods of tapping and preparation of latex, through its agricultural stations. Attempts have also been made to cultivate *Funtumia elastica*, but the plants have suffered greatly from violent winds and tornadoes.

RUBBER IN THE FRENCH COLONIES.

French colonial possessions exported over 400,000 pounds of crude rubber and 363,999 pounds of balata gum during 1914. Of the crude rubber Cochin China exported at least 300,000 pounds, and the French Ivory Coast colony about 93,422 pounds, while the balata gum was all exported by French Guiana. Of the Cochin China rubber, 292,761 pounds went to France, the balance to Singapore ; less than 80 pounds of the total was forest rubber, the remainder being all of the plantation type.

HEVEA IN DAHOMEY COLONY.

A French colonial inspector reports that a group of *Hevea brasiliensis* trees planted in 1898-1899 near Porto Novo, French Dahomey colony, is now producing exceptionally well. Prior to 1914 these trees received no regular attention, but in August last year a real attempt at tapping was made, and the trees yielded from 2 to $4\frac{3}{4}$ pounds of dry rubber each. Those trees that yielded only 2 pounds of dry rubber were plants that had been mistreated in the course of former tappings, and had not altogether recovered from the abuse they had suffered. The swampy soil of the Dahomey colony appears to be especially well suited to *Hevea brasiliensis*.

"GOHINE" RUBBER.

The French Colonial Department has recently made experiments with samples of rubber prepared from the latex of a vine known as the "Gohine" (*Landolphia Hendelotii*), obtained from the Upper Senegal and Niger districts of French West Africa. Part of this latex came from Konakry, where it was coagulated with lemon juice, part from Koury, where it was produced by spontaneous coagulation. Vulcanized fine Para hard cure was used as a standard in comparing the vulcanized products of these different samples of "Gohine" latex, and the experiments showed that the difference in the manner of coagulation had but very little effect on the vulcanized product. Samples of "Gohine" latex obtained from Portuguese colonies, where it was coagulated with such vegetable acids as lemon juice, Guiana sorrel juice, "manina" and the like, show, when vulcanized, but slight technical differences. "Gohine" rubber can be classed among good vine rubbers, suitable for industrial purposes.

THE TACKINESS OF RUBBER.

Sometimes, in the course of transportation or in storage, crude rubber becomes "tacky," thus losing its elasticity and nerve. This phenomenon has often been attributed to the action of microbes, but a French scientist—M. Bertrand—attributes this alteration or decomposition of crude rubber to the action of physico-chemical agents. He states that when rubber becomes "tacky" it is due to a molecular transformation. Exhaustive experiments made by F. Heim and R. Marquis confirm Bertrand's views, for they state, in giving an account of their experiments, first, that the turning of crude rubber into a pitchy, tacky mass is due to the absorption by the rubber of the oxygen of the air, this absorption being favoured by a rise in temperature ; secondly, that a small quantity of oxygen is sufficient to decompose a large quantity of rubber, and thirdly, that smoking after coagulation preserves rubber from becoming tacky, at least under the conditions present during their experiments. Air is therefore the enemy of crude rubber, which, in order to keep, must be preserved from it. The action of smoke is to cover the crude rubber with a coating that preserves it from air, and therefore formaldehyde and creosote are not really the preserving factors of the smoking treatment of rubber.—India Rubber World.

THE MANUFACTURE OF PENCILS.

The Committee employed Mr. Luber, a pencil expert, to inspect the Shimoga forests where varieties of soft white woods suitable for pencils are available and to submit a report on the practicability of starting the manufacture of pencils in Mysore. The results of his investigation indicate that 40,000 cubic feet of suitable wood can safely be estimated as the annual yield of the forests at Shimoga. Specimen pencils out of the wood locally available were prepared, and estimates for a pencil factory with an outturn of 300 gross of pencils per day, absorbing about 11,000 cubic feet of wood per annum, were submitted. It was ascertained from independent inquiry that the market in Southern India for pencils is sufficient to absorb the whole output of the factory and the estimates prepared by the expert showed that pencils can be made locally with a fair margin of profit. In view of the fact that the industry on the scale contemplated was quite new to India, Government were recommended to pioneer the industry in the State by establishing a pencil factory with a capital of Rs. 150,000, as a Government undertaking. Unfortunately no action could be taken just then on account of the War. Government have recently passed orders to the effect that the question of pioneering the industry will be considered if private enterprise does not come forward to establish the industry in the State.—Ann. Rept., Industries and Commerce Committee of the Mysore Economic Conference.

COTTON.

HINTS ON COTTON CULTIVATION.

Season.—It is important that the season chosen should be one that insures that at the harvesting there should be little or no rain. During the first three months of growing, flowering, and bolling there should be constant showers, and during the last two months bright dry weather for the bolls to open. Too much rain at the time the bolls are setting, i.e., at the end of the third month and in the fourth, will cause many to drop off.

Situation.—The ground should have good natural drainage ; any depressions in which stagnant water lies damages the crop.

Preparation of Land.—The land should be ploughed at least twice, and three times is better still, so that the soil is well mixed and pulverised in the cross-ploughing. If cattle or artificial manure is to be applied it should be broadcasted after the first ploughing. The land should then be set out in ridges 3-4 feet apart, especially when the crop is to be irrigated.

Planting.—The distance apart must depend on the variety ; thus for Allen's Long Staple, grown in rich soil 4 ft. × 1½ ft. apart is not too much, but for smaller varieties such as Egyptian on medium soil (a really poor soil is useless for cotton) 2½ × 1½ feet is recommended.

Holes should be ½ inch deep, half-way up the ridge and on one side only, if the ridges are the proper distance apart.

Only selected seed of good quality and a bona fide variety should be sown. Seed kept from the bulk of the last crop will always yield a deteriorated cotton.

If the weather is dry at the time of sowing, the seed may be soaked in water for a few hours before sowing. 6-8 seeds should be sown in each hole, and they should germinate within a week.

When the plants are 15 inches high they should be thinned out so as to leave the two strongest plants. Those with a red dot at the base of the stalk and leaf are of the poor variety known in Egypt as "Hindi" cotton, and should always be taken out.

Cultivation.—The ground must be kept as clean as possible and free from weeds during the growing period. As soon as the plants are 2 feet high drag soil towards the plants so as to strengthen the base and support the stem. This can be done when weeding, with a mamotty ; the soil should be piled 2 or 3 inches high round each plant, and it is a safeguard against the plants being blown over by the wind. Always make the rows to run north-east and south-west, as they are less liable to be damaged by the wind. Cultivation of soil should be finished before the plants obtain their full growth : as soon as flowering commences and the bolls setting the plants should as far as possible be left undisturbed.

Supplies.—All vacancies should be noticed as early as possible and replanted with *seeds*. Do not supply with plants when thinning out as they never do any good—probably because the long tap root has been injured. I have never succeeded in any transplanting.

Pests.—When the plants are well up, the field should be carefully gone over and all leaves with egg-masses (generally on the underside of the leaves) should be picked off and put in a basket and *burned*. All the caterpillars and other insects should be collected and destroyed. This will prevent the spread of boll-worm, which does so much damage to the cotton directly the bolls make their appearance.

It is important that all the cotton stems should be burnt on the fields directly the cotton is harvested, for, if left, the boll-worm and other pests will breed and multiply in the standing stalks and, hiding in the soil, lie in wait for the next crop.

Harvesting.—At an early stage plants burst a few bolls; they should be left alone. It does not pay to gather the crop in small quantities. The greatest care should be exercised in plucking the cotton clean. Never permit a cooly to offer dirty cotton, with little broken pieces of leaf in it; have it all *carefully* picked over. *This is most important.* The whole financial success of cotton depends upon its cleanliness. It must be absolutely clean, and to secure this the greatest care and vigilance is necessary. A conductor who is slack in this respect is useless, and what is more he is cheating his employer. One dirty bale will condemn the rest of the shipment and make a difference between a very substantial profit and a serious loss. Once gain a reputation for clean cotton and your goods will always command a ready sale. Never pick when the cotton is damp with dew or after rain, or before the bolls are properly open and the cotton quite ripe.

Grading.—When it is received at the store have it spread out on a platform, exposed to the sun, so as to thoroughly dry before putting away and give the cotton a silky appearance. The first, second and third pickings should always be kept quite separate and the sacks marked, because the first picking is always the most valuable and should fetch a higher price, whereas if the pickings are all mixed together the grade on the whole is considerably lowered. Check all weights carefully. Weigh each picking, weigh the bulk to make certain of being correct and also to avoid being cheated by the pickers. Get the cotton ginned as soon as possible, in order to avoid loss from squirrels and rats and stow away in a dry place.

D. S. CORLETT.

GROWTH OF MILLET AND SORGHUM.

Millet (*Sorghum vulgare*) was drilled on May 14th at the rate of 20 lb. per acre in rows 7 in. apart; the crop reached 7 ft. in height and remained erect. It yielded $22\frac{3}{4}$ tons of green fodder per acre when cut on August 17th. The crop is useful as giving an early supply of green fodder in dry seasons; the seed costs about 3*d*. per lb.

A small plot of *Sorghum saccharatum* sown on May 14th produced 25 tons 6 cwt. of green fodder per acre.

Dhura (yellow branching) and white Kaffir corn, plants similar to sorghum and millet, produced 19 tons 3 cwt. and 23 tons 9 cwt. per acre respectively of green fodder.—Journal of the Board of Agriculture.

RICE.

SUBSOIL DRAINAGE IN PADDY SOILS.

R. CECIL WOOD

This paper is a short account of the experience gained in laying down subsoil drains in paddy land.

The ground chosen for the experiment was about $1\frac{1}{2}$ acres in extent and is not affected by excess of water. It was more in the hope of reducing the alkalinity from which the land suffers, that the experiment was carried out.

Eight drains were laid 21 feet apart : each drain was 400 feet in length and had a fall of from 1·35 to 0·7 feet.

Two kinds of drains were used : one, a plain loose stone one, the other made of bamboo tubes. The drains were 2 feet 6 inches deep, the stones being filled in to a breadth of 1 foot and a depth of 6 inches. The bamboos were also packed in stone to a depth of 6 inches. The tubes were simply bamboos of about 3 inches bore cut at the internodes into lengths of about 1 foot 3 inches. The diaphragms were removed and the whole piece dipped in tar. They were laid end to end, being threaded up on long thin bamboos. The cost of the stone drains was 8·82 pies per running foot or Rs. 95·7·3 per acre, that of the bamboo drains, 10·14 pies and Rs. 109·11·10 respectively.

The drains were laid in 1910 and after 3 years cropping have recently been examined. The bamboos were found in a very good state of preservation, but were blocked in several places by silt, owing to displacement of the pipes and to the inadequate fall. This latter is the main difficulty, since on this class of land a considerable fall is seldom available.

That these drains have resulted in an improvement in the land, there is little doubt. A more alkaline piece of land has now been chosen for further trial, since if such land could be reclaimed at Rs. 100 an acre it would show a very large profit.

Other experiments of underdrainage were carried out at Saidapet in Madras.

More recently experiments have been made at Sivagiri. Stone drains were laid down in clayey alkaline land and have been running well for five years, to the marked improvement of the land.—MONTHLY BULLETIN.

THE YIELD OF RICE.

The Philippine Agriculturist and Forester publishes the following table showing the yield of rice in the chief rice-growing countries.

Country.	Area under rice in acres.	Production in tons.	Yield per acre in bushels of 45 lb.
Spain	96,000	246,000	126·6
Italy	360,000	534,000	73·3
Egypt	254,000	375,000	73·3
Japan	7,393,000	7,026,000	46·6
United States ...	827,000	517,000	33·3
India	70,580,000	28,167,000	19·7
Philippine Islands ...	2,991,000	723,000	10·7

RAINFALL FOR MAY AND JUNE.

Place	May		June	
	1915	1914	1915	1914
	in.	in	in	in.
Colombo	11·03	14·30	7·96	10·29
Kandy	5·04	5·80	6·14	9·30
Galle	23·04	9·82	6·16	11·15
Jaffna	3·35	·76	·07	·56
Anuradhapura	·72	2·75	1·70	·26
Kurúnegala	1·07	4·01	6·18	5·88
Batticaloa	2·35	1·20	·44	1·15
Badulla	1·81	3·64	3·99	·66
Ratnapura	30·65	17·46	21·21	16·51
Nuwara Eliya	3·30	3·16	12·02	10·90

FRUIT.

PRUNING AND TREATMENT OF BANANA SUCKERS.

R. G. BARTLETT.

In Jamaica a great deal of attention is given to this subject in order to produce fruit when the market demand is keenest and prices, therefore, highest.

Queensland growers know the great difference in prices obtaining in January and February compared with those of May to September or October. The returns from plantations would be very materially increased if we could regulate our fields to grow bunches in, say, March or April. These bunches are always large and they mature during the months of good prices.

It has been the practice on the school plot to carry out the main pruning in February and March. At that time a fair-sized "follower" is left to each of the three main suckers forming the stool. During the rest of the year the small "peepers" (suckers) are pruned out as they appear. The result has been that 66 per cent. of the total crop has been harvested in the six months, June to December. Actual figures are 54 bunches for six months, January to June, and 103 bunches from July to December. Out of the total 157 bunches only 24 bunches were harvested in January and February—months of wet weather and exceedingly low prices.

Of course it will require careful testing before conclusive results are obtained to show which is the best month or months to allow "followers" to go ahead in order to gain the desired end—i.e., majority of bunches harvested during time of best prices. In this connection, the views of your readers who have considered this matter would be valuable if you could spare space in your journal for the discussion of this subject.—Queensland Agricultural Journal.

THE SEX OF PAPAW PLANTS.

Mr. Ernest C. Davies, Charters Towers, writes :—

"Mr. C. Ross, in your May number, tells 'A. H. F. Diddillibah,' that there is no way to tell sex in young papaw plants. Here's an idea that is advocated by Mr. George Johnson, Curator of Lissner Park, Charters Towers. I have tried it repeatedly with marked success. To get females, plant only about 5 per cent. of your seedlings, choosing the very smallest and sickliest-looking plants. Destroy all the big strong fellows. Watch for the plants that come up after the main lot have germinated ; they are often females. The idea is taken from the general rule of nature, that the female is mostly weaker and smaller in infancy. Watch a litter of puppies or a batch of chickens, for instance. Of course, the rule is not absolutely certain, for there is often a sickly male in every part of Nature, and vice versa, an extra sturdy female ; but I get over 50 per cent. of female papaws in this way, and I recently scored twenty-four out of twenty-five plants."—Queensland Agricultural Journal.

SOILS AND MANURES.

GROWTH OF PLANTS IN PARTIALLY STERILISED SOILS.

E. J. RUSSELL AND F. R. PETHERBRIDGE.

Seven important directions have been found in which partially sterilised soils differ from untreated soils as media for plant growth.

(1) There is generally a retardation in germination but sometimes partial acceleration (i.e., affecting some of the seeds only).

(2) There is generally an acceleration in growth up to the time of the appearance of the third or fourth leaves, but sometimes a marked retardation, especially in rich soils heated to 100° C. We have failed to discover the conditions regulating the retardation, and can never predict with certainty whether or not it will set in. On the whole we have observed it more frequently during dull winter days than in the brighter spring or summer days.

(3) When this retardation occurs it is accompanied by a very dark green leaf colour and either the formation of a purple pigment or a tendency for the leaves to curl towards the under side. The whole appearance is strongly suggestive of an attempt on the part of the plant to reduce assimilation.

(4) Later on the purple colour goes and the curling ceases; rapid plant growth then takes place. The subsequent growth is finally proportional to the amount of food present.

(5) Plants grown in soils heated to 100° show a very remarkable development of fibrous root unlike anything obtained on untreated soils.

(6) Plants grown on soils heated to 100° have, in comparison with those on untreated soils, larger leaves of deeper green colour, stouter stems, usually shorter internodes; they flower earlier and more abundantly, and contain a higher percentage of nitrogen and sometimes of phosphoric acid in their dry matter; the roots give up their nitrogen, phosphorus, and potassium more completely to the fruit.

(7) Plants grown on soils heated to 50° or treated with volatile antiseptics showed fewer of these effects; there is only rarely a retardation in seedling growth but usually an acceleration, sometimes a rapid one, succeeded by a period of steady growth which is finally proportional to the amount of plant food present. No specially marked development of fibrous root or shortening of the internodes occurs, but there is an increase in the percentage of nitrogen and sometimes of phosphoric acid in the dry matter as compared with plants raised on untreated soils, and also a more complete translocation of these materials to the fruit—Rothamsted Experiment Station Report 1913.

LIME REQUIREMENTS OF CERTAIN SOILS.

H. B. HUTCHINSON AND K. MACLENNAN.

This paper (Jour. Agricultural Society, March, 1915) deals with the lime requirements of certain soils (a) for sterilisation purposes, (b) for neutralisation purposes.

STERILISATION.

Calcium oxide (caustic lime) can produce partial sterilisation effects but not calcium carbonate (chalk, limestone, marl, etc.).

The amount of lime necessary to produce specific effects in different soils has been found to vary greatly and it is not possible to make any general recommendations. The method proposed for indicating the critical amount required is based on the determination of the amount necessary for the production of an alkaline reaction of the soil water; the amounts thus indicated agree very closely with those required for the production of typical partial sterilisation effects in the soil itself, e.g., the inhibition of protozoa and nitrifying organisms. The amount of lime thus indicated not only gives the maximum production of dry matter in the *first* crop following treatment, but also in the first *four* crops.

Certain physical changes also occur about the partial sterilisation point.

NEUTRALISATION.

The method described for the determination of the lime requirements of the soil is based on the absorptive capacity of the soil for calcium carbonate, this method having the advantage that no absorption is indicated in the case of neutral soils. An application of carbonate to a soil exercises a marked effect in accelerating the process of ammonification, and, to a less degree, nitrification; soils showing a positive lime requirement according to the proposed method have been found to respond distinctly to the application of carbonate (a) by increased ammonia and nitrate production in laboratory experiments, and (b) by greater plant growth in pot culture and field work.

The values of calcium oxide and carbonate have been shown to be identical, provided that the lime requirements for neutralisation purposes are not fully satisfied. After the neutral point is reached calcium oxide exercises its specific effect (see sterilisation above).

In the case of soils on the same geological formation a definite relation between soil reaction and natural flora has been traced. The occurrence of certain plants on acid soils appears to be determined by their capacity of resistance to acidity.—Journal of the Board of Agriculture.

GREEN MANURING EXPERIMENT AT ROTHAMSTED.

Throughout the Rothamsted experiments a number of observations have shown the marked effect of ploughing-in a green crop or a crop residue as a preparation for a succeeding crop. Every four years the residues of a clover crop after carting the hay are ploughed-in on half of the Agdell Field,

and the effect on the succeeding crops in the rotation is recorded. In Hoos Field some leguminous crop has periodically been ploughed-in and a number of grain crops have then been grown, almost always with beneficial results.

The growing scarcity of stable manure renders it imperative that some method should be worked out whereby the farmer can get all the benefit of stable manure in some other way, and green manuring affords an obvious means of doing this. Experiments in the laboratory and pot culture house, however, showed that the growing plant has a complex effect on the soil and on other crops, and that one could not without further trial advocate unrestricted green manuring. For example, it was found that the growing plant apparently depressed nitrification and other bacterial actions in the soil, and that some interval was needed between two crops in order that the bacterial processes might become completed.

Another action is indicated as the result of Mr. Pickering's work at Woburn: one growing crop has an injurious effect on another growing crop apparently through exerting some deleterious influence on the soil. It appears, therefore, that there is another side to the question, and that a growing crop not only takes out certain plant foods (which are automatically returned when the crop is ploughed-in, or can be added as artificial fertilisers), but it may also have other effects. This is while it is actually growing: the residues ploughed-in seem to be wholly beneficial—at any rate no ill-effect has yet been detected in the field, although one (a destruction of nitrate in certain circumstances) has been indicated in the laboratory. So far as our present knowledge goes the best results are only attained when a period of fallow comes after the green manure crop.

Thus green manuring is intimately bound up with fallowing. It was shown in the last Report that fallowing had a very beneficial effect on the crop of barley and further observations to the same effect have been made this year. Winter oats on Sawpit Field taken after a fallow were better than crops fertilised with nitrogenous manures. No green manure or crop residue was ploughed in either for the barley or oats, but this year an experiment was made to find the effect of combined crop residues and fallow on wheat. A four-year-old lucerne ley on Broadbalk Field was broken up, fallowed during the hot weather and sown with wheat in October, 1913. The land had received no manure for some years, but the wheat crop was greater than on any plot receiving artificial manures, and at least as large as that on plot receiving 14 tons of farmyard manure. Even more remarkable, however, was the effect on the weight of the grain. Practically all the wheat on the regular plots, with the exception of the unmanured, had the same density, viz: 62·2 lb. per bushel, this being independent of the amount or nature of the fertiliser used. The wheat after lucerne had a heavier grain, weighing 63·9 lb. per bushel.

But in regard to fallowing a difficulty at once arises. While the land is lying fallow it is subject to loss of nitrates by leaching; indeed one of the great merits of green manuring is that it puts a crop on the land in autumn when the stock of nitrates is high and the crop takes up the nitrates and holds them safely from the winter rain. A simple way round the difficulty is to have the necessary fallow only during the dry weather, and it so happens that all our experiments were made under these conditions.

It is to clear up these and similar problems that a definite green manuring experiment has been begun. A field is divided into four parts, one of which is farmed with artificials only, one with farmyard manure and artificials, and two with artificials and green manure but no farmyard manure. One of the two last carries leguminous crops and the other non-leguminous crops for the green manure. An eight-year rotation has been drawn up to keep the green manured land as closely cropped as possible, and to reduce to a minimum all losses by leaching; whether other losses will also be reduced has yet to be determined. The eight-year run should show how far green manuring can be regularly practised under farming conditions, and whether periodical fallows will be necessary.

Meanwhile, in view of the marked benefit just recorded of the fallow coming after the lucerne ley and of other results of like nature, the question arises whether, in a dry summer, it is worth while to trouble about the aftermath of the seeds or clover ley (unless wanted for clover seed), and whether it would not be better to take the first cut early and plough up immediately so as to secure a long bastard fallow before the next corn crop. Under dry conditions the aftermath may be worth only little, while the benefit of the fallow is great. The practical difficulty on a heavy loam like ours consists in breaking up a hard baked ley at midsummer sufficiently quickly to avoid interference with other work. Not only for this purpose, but for the general object of being well forward in autumn, there is great need on medium sized heavy-land farms of a plough which will cheaply and efficiently do more than the one acre a day that has for untold years been considered the ploughman's proper and sufficient duty.—Rothamsted Expt. Stn. Ann. Rept., 1914.

SEWAGE SLUDGE AS MANURE.

The conclusion of the enquiry of the Royal Commission on Sewage Disposal with the presentation of their Final Report affords an opportunity for reviewing the position as regards the use of sewage sludge as manure.

Small amounts of human excreta are of course applied to the land as such, with or without some preliminary treatment, but the fact that a water-borne system of sanitation is almost everywhere prevalent necessitates the use in some way of sewage as manure if the valuable manurial ingredients of human excreta are not to be allowed to go to waste. Sewage has found application on sewage farms for crops such as cabbages, turnips, mangolds and grass. Its employment in this way, however, has been limited, since large volumes of liquid have to be dealt with, of which even the best-adapted soils can absorb only relatively small quantities, so that considerable areas of land are necessary; and sewage farming in general does not seem to have been a great commercial success.

A further method of utilising the manurial ingredients of sewage, to which much attention has been given, is the application of sewage "sludge" to the land. At the sewage works where the sewage is treated for purification the coarser solids are first removed; after this the finely-divided matter in suspension is removed either by sedimentation, or precipitation with

chemicals, or septic treatment. The "sludge" is the sediment so obtained, and in view of its content of nitrogen, phosphate and a small amount of potash, attempts have been made to utilise this product as manure.

It has been found that the most convenient way of disposing of this sludge is to press it into a "cake" after mixing it with lime. In some cases a charge of about 6*d*. per ton is made for it, but in others the sludge is given away to neighbouring farmers, or a small fee may even be paid for its removal.

Speaking generally, properly pressed sludge when in the form of solid cake does not give rise to serious nuisance from smell, and if exposed to the air in dry weather it soon becomes entirely inoffensive. It has, however, a slight smell of fresh sewage, and if kept moist, e.g., if it is exposed to the air during wet weather, it soon becomes putrid and gives rise to offensive odours. For this reason it should, if possible, be stored under cover until it can be distributed on the land, or covered in.

The composition of the pressed cake varies according to its origin; in addition to its manurial constituents it naturally contains a good deal of lime. The actual market value, however, is insignificant owing to the relatively high cost of carriage upon a mixture containing of necessity a large proportion of water, grit, and carbonaceous matter.

Experiments with regard to the use of various sewage sludges in agriculture were first carried out for the Royal Commission on Sewage Disposal about ten years ago.

Professor Somerville's trials with turnips, mangolds and swedes at five centres did not reveal any consistent manurial effect from the sludge; and the conclusion was drawn that the nitrogen and phosphoric acid of sludge are in a much less available form than the same substances in sulphate of ammonia, superphosphate and fish meal.

In experiments carried out by Mr. Middleton on grass at eight centres the application of the sludge seems to have been useful for the hay crop in the north where the wet summer experienced favoured slow-acting manure, but the sludge produced no results in the south of England. The conclusions were drawn that, for root crops and grass, the action of the nitrogenous and phosphatic constituents of sludge is very slow as compared with the effect produced by nitrogen and phosphates supplied in ordinary artificial manures; that sewage sludge would not appear to be well adapted for such crops as mangolds, potatoes and swedes, which have a short period of growth and require quick-acting manures, and if employed it should be applied in tons rather than in hundredweight per acre; that proper quantities of sludge would be likely to form a good dressing for the slow-growing plants of many permanent pastures and meadows; and that sludge is unlikely to give satisfaction on the very poor clay-soil pastures which are so much benefited by basic slag.

Dr. Voelcker found in pot-trials with wheat that those sludges did best which contained most moisture and most lime, but that high amounts of organic matter and of total nitrogen did not produce a correspondingly good result, while all the sludges tried were somewhat inferior to artificial manures supplying equal amounts of approximately like ingredients. An increase of 10 to 12 per cent. in corn and in straw over the unmanured produce was, on the average, obtained, as against one of 16 to 17 per cent. with artificial manuring. Based on the extra produce obtained the best of the sludges was valued at 10*s*. a ton delivered on the land.

The experiments for the Royal Commission on Sewage Disposal did not end with the above trials, owing to the subsequent discovery of an efficient process for "de-greasing" the sludge. It must be explained that natural sludge contains a large amount of grease and soapy matter (equal to form 10 to 15 per cent. of the dry matter). Grease is of no value as manure and, in fact, is supposed to exercise a retarding influence by preventing the ready decomposition of the organic and nitrogenous matters with which it may be mixed.

The effect of these "de-greased" sludges was compared with that of natural sludges on wheat at Woburn and on hay and oats at Rothamsted in 1913-14.

At Woburn the natural sludge was found to contain more moisture, more nitrogen and more soluble nitrogen than the de-greased, an application of 1 ton per acre supplying 45 lb. of nitrogen in the case of natural sludge and 40 lb. in the case of de-greased sludge. The following table shows the yields of grain and straw from various dressings :—

Treatment.	Weight of produce (untreated—100).	
	Corn.	Straw.
Untreated	100	100
Natural sludge :		
1 ton per acre	122	102
2 tons per acre	120	112
1 ton per acre + ½ ton lime ...	132	110
De-greased sludge :		
1 ton per acre	101	107
2 tons per acre	118	102
1 ton per acre + ½ ton lime ...	122	111
Lime only— ½ ton per acre ...	113	102

Thus the average increase in grain over the untreated produce was 25 per cent. with the natural sludge and 14 per cent. with the de-greased. The best results were obtained with lime, but that this was not due to lime alone is shown by the yields where lime was applied without sludge.

At Rothamsted, also, the nitrogen content of the natural sludge (1·76 per cent.) was found to be above that of the de-greased sludge (1·55 per cent.) while the content of phosphoric acid was 0·85 and 1·33 per cent. respectively

In the grass experiments the manures were applied at the uniform rate of 20 lb. of nitrogen per acre (equivalent to about half a ton of sludge) with

the following results:—

Treatment.	Yield of Hay per acre. cwt.
Untreated	17·64
Natural sludge	18·64
De-greased sludge	16·29
Calcium cyanamide	21·59
Nitrate of soda	25·93

The effect of the sludges was negligible. It should be mentioned that the season was a distinctly dry one.

Experiments with oats were carried out on the same plan, but from neither of the sludges was so good a return obtained as where no treatment was given, the sludges being applied so as to supply 16·67 lb. of nitrogen per acre.

The results of the Rothamsted experiments are taken to indicate the lack of evidence to the effect that the removal of the fat from the sludge increases the ease of decomposition in the soil.

The point towards which laboratory and other experiments should in future be directed seems to be the discovery of some method of rendering the nitrogenous matter of the sewage sludge more readily available as plant food than at present.—Journal of the Board of Agriculture.

THE FLUCTUATIONS IN NITRATE CONTENTS OF SOILS.

E. J RUSSELL.

The amount of nitrate in the soil of arable land fluctuates regularly, but in these experiments it rarely exceeded the following values:—

	Per million.	Per cent.	Lb. per Acre, 0-18 ins.
Sand ...	6	·0006	28
Loam ...	23	·0023	115
(excepting on heavily dunged land, when it rose to 37 parts per million).			
Clay ...	14	·0014	60

In almost all the soils examined accumulation of nitrate took place most rapidly in late spring or early summer. After this there was usually little if any gain, and frequently a loss. In the hot dry autumn of 1911, however, and again in 1913, the accumulation continued in some of the soils right on till September.

During the winter loss of nitrate took place. This was more marked in the wet winter of 1911-1912 than in the drier winter of 1908-1909.

The fluctuations in nitrate content are more marked on loams than on clays or sands. Clays lose less of their nitrates in winter, but, on the other hand, they accumulate smaller amounts in June and July. Sands lose much of their nitrates in winter and do not accumulate very large amounts in summer. It appears that the main loss in winter is due to leaching and not to denitrification.

On comparing the nitrate content of cropped and fallow land it is found that during the late summer and early autumn the fallow land is the richer even after allowing for the nitrate taken up by the crop. The question arises whether the growth of a crop exerts any depressing effect on the rate of nitrate production in the soil. This is under further investigation.

The rapid rise in nitrate content in spring does not usually set in immediately the warm weather begins; there is a longer or shorter lag. There are indications of greater bacterial activity in early summer than later on, a phenomenon readily explicable on our view that the soil population is complex and includes organisms which are detrimental to the activity of bacteria, but which are, on the whole, more readily put out of action.

The supply of nitrate to the plant is known to be a factor of prime importance in plant growth. Similarly it is found that the factors which determine the accumulation of nitrates in the soil also play a great part in determining the amount of crop production. Thus heavy winter rainfall, which washes out nitrates, tends to reduce crop growth; on the other hand, hot dry summers, succeeded by dry winters, are shown to be favourable to nitrate accumulation, and therefore to crop growth.—Rothamsted Expt. Stn. Ann. Rept., 1914.

CRUSHED BONES FROM MYSORE.

A considerable quantity of bone is being exported from the State and all the bone manure required by the coffee planters is being imported from outside. It has recently been decided to start a joint-stock company at Chickmagalur to manufacture bone manure. The capital of the company will be Rs. 40,000 half of which is proposed to be called up in the first instance. The capital called will be expended on buildings, machinery, and a coffee hulling plant proposed to be installed in the factory, the working capital being furnished either by Government or Bank of Mysore, on the security of the property of the company and the uncalled capital, The factory is estimated to crush 1,200 tons of bone per annum. An application for certain concessions by a private syndicate who propose to set up a Bone factory in Bangalore is also under consideration.

A note on the other manurial possibilities of the State prepared by Mr. Sambasiva Iyer, one of the members of the Committee, is under consideration,—Annual Report Industries and Commerce Committee of the Mysore Economic Conference.

AZOTOBACTER IN SOILS.

FR. WEIS AND C. H. BORNEBUSCH.

The present investigations, which dealt with a series of soils taken from Danish forests, form part of the experimentation, which is to be continued in future years, intended to throw light on the natural store of nitrogen in the soil. While so far it has not been demonstrated that green plants (that is those containing chlorophyll) can fix and absorb nitrogen without the

agency of micro-organisms (fungi or bacteria), several fungi and bacteria are known to possess such power, either alone or in symbiosis. Among these the one which has attracted most attention of late is *Azotobacter*, because it is generally widespread in fertile field and garden soils, to whose nitrogen supply it contributes to an appreciable degree. It was thus obvious to investigate the presence of *Azotobacter* also in forest soils, all the more so as they are capable of maintaining their equilibrium in nitrogen for long periods without artificial manuring; moreover, several writers have observed a considerable increase in comparison with the absolute quantity of nitrogen contained in the leaves that fall to the ground. Recently it has been shown that the presence of *Azotobacter* in arable soil depends upon its reaction and on its content of certain compounds of lime and humus; consequently, it is not so generally distributed as was formerly believed; it seems to be rare in peaty soils, and has been shown to be absent from a series of Swiss forest soils, though present in the leaf mould layer.

For the experiments here described, samples of soil were taken from 64 different localities in Danish forests (in Seeland, Laaland and Fünen) and examined in the Laboratory of Agricultural Bacteriology of the Royal Agricultural and Veterinary College in Copenhagen. They were sown in the nutritive solution recommended by Beijerinck for *Azotobacter*. Every sample of soil was tested with litmus paper and for calcium carbonate (effervescence with cold, dilute hydrochloric acid); lastly, for 54 samples, *Azotobacter* was inoculated into 50 cc. of a solution similar to Beijerinck's, but with the calcium carbonate substituted by 5 grams of the soil to be examined; thus the bacterium has no available source of lime but that contained in the added soil, and from its development after a few days at 25° C. the lime requirements of the soil may be interred. (Harold R. Christensen's method).

The principal results were the following: Of the 64 localities investigated, only in two (the soil of which showed marked effervescence and alkalinity) was *Azotobacter* found, in both cases in the soil of beech woods. It did not, however, belong to *A. chroococcum*, form generally present in arable soil, which after a few days' culture becomes blackish-brown, but to one which forms films which remain whitish; hence it probably belongs to *A. beijerinckii* or *A. vitreum*. The same whitish form was also found on a black moor soil flushed by spring-water and overgrown with ash and alder, at Folehaven (Seeland), and by a roadside at Ordrup-Krat (Seeland), both soils giving marked effervescence with hydrochloric acid.

The forest soils examined rarely contained sufficient calcium carbonate to cause effervescence with hydrochloric acid, even in the numerous cases in which their reaction was neutral or slightly alkaline. Nevertheless they were not without lime in other forms, and could not be defined as requiring liming. The culture experiments with *Azotobacter* gave positive results in 32 cases and negative ones in 22; even in the former, the good development of the trees and the good physical condition of the wooded soil showed that there was no need of liming. In several cases the dry leaves fallen to the ground were examined for *Azotobacter*, but always with negative results. In the cases in which it was looked for in arable soils in the immediate vicinity of woods whose soil did not contain any species of *Azotobacter*, its presence was easily demonstrated, but the species was always *A. chroococcum*.

The following general conclusions thus seem justified :

1. *Azotobacter* is only exceptionally present in Danish forest soils ; in some localities in which the soil contains much calcium carbonate, *A. beijerinckii* and *A. vitreum* are present. Consequently, for the supply of nitrogen to the forest soils of Denmark some other micro-organisms, probably lower fungi, must be of importance. The causes of the absence of *Azotobacter* from forest soils are perhaps the insufficient quantity of calcium carbonate, the too low temperature and an excess of humic matter.

2. *Azotobacter*, perhaps on account of the low temperature, seems not to be generally present on the fallen leaves in Danish woods.

3. The culture of *Azotobacter* in BEIJERINCK'S nutritive solution in which the lime is replaced by 5 gms. of the soil to be studied, namely HAROLD R. CHRISTENSEN'S method, is a rapid and easy way of showing if a woodland to be regenerated requires lime or not ; since the calcium compounds that favour the development of *Azotobacter* in such cultures seem to be the same which facilitate the development of those organisms which lead to the production and conservation of a good mould and favour the development of forest trees, especially of beeches.—MONTHLY BULLETIN.

CARBON DIOXIDE AND THE GERMINATION OF SEEDS.

An interesting review of a paper appearing in the PROCEEDINGS OF THE ROYAL SOCIETY is to be found in the AGRICULTURAL JOURNAL OF INDIA for January 1915. It is pointed out in this that the writer of the paper had previously determined the inhibitory action of carbon dioxide, especially in the seed itself. Germination can also be arrested by the carbon dioxide produced by decaying organic matter in the soil. Especial reference is made in the course of the review to the germinating power of Para rubber seeds. It is well known that in planting the seed under estate conditions, it is always desirable to put the seed in the ground within a fortnight. On this account some practicable method of extending the life of the seeds is desirable. It was found that bottling up the seeds with air in flasks gave far better results than the commercial method now in use of packing these seeds in a mixture of charcoal and ashes. It is suggested that the partial pressure of the carbon dioxide inhibits deterioration ; the carbon dioxide is in fact in this case a preservative agent. The reviewer attaches much importance, as regards India, to the author's results in regard to green dressings which concern largely the production of carbon dioxide in the soil already referred to above.—THE AGRICULTURAL NEWS.

PAPER PULP.

THE EMPIRE'S RESOURCES IN PAPER-MAKING MATERIALS.

Mr. Chas. Phillips, m.s.c.i., lecturing on this subject before the Colonial Section of the Royal Society of Arts, refers to the possible sources of paper-making materials obtainable in the British Dominions and Dependencies.

Canada stands out pre-eminent among suppliers of paper-making materials.

Cheap papers are now produced mainly from wood-pulp. While England still depends largely on Scandinavia for this material Canada is the next most important source and at present supplies the world with 320,000 tons of paper-making materials as wood or wood pulp.

The paper-maker relies chiefly on rags, esparto grass and wood, but there are many other materials which are also used or likely to prove useful. At the same time a number of fibres which have been examined have not proved to be of much value. Among the last may be mentioned the Baobab, Heliconia, Bihai, *Lepidosperma gladiatum*, and *Phragmites communis*, all of which were investigated and found more or less disappointing.

Tests made with Majorca and *Uniola virgata* went to indicate that they were something to fall back upon. The Californian cactus, worked on by Dr. King of Calcutta, gave indifferent results, while the expectations held out by *Calatropis gigantea* proved disappointing.

Cavanillesia platinifolia, pulped and bleached exceedingly wella nd proved capable of being turned into strong white paper of fine quality : but *Opuntia* was found of no economic value

Broussonetia papyrifera, of tapa cloth fame, was considered by Routledge as nearly if not quite the best of fibres, requiring little chemical treatment and yielding 62·5 per cent. boiled equivalent to 58 per cent. bleached.

Encouraging results were at one time obtained from the giant bamboo and considerable attention given to *Molinia cærulea* (rye straw): while in 1880 Muddar was reported on as a commercial possibility. But Mr. Liotard's valuable report on Indian paper-making material did not consider any fibre as being a serious rival to Esparto, particularly for supplying British paper-makers.

At the present time the fibre of *Nipa frulicans* is under trial, and promises well as a material for making strong boards and packing papers.

Considerable attention has recently been given to *Imperata arundinacea* (our "Iluk") which appears to range between Spanish esparto and good straw fibre.

The lecture referred to is reported in the Paper Maker and British Paper Trade Journal.

BAMBOO AS A SOURCE OF PULP.

In view of the fact that some attention is being given in Trinidad to the utilization of the bamboo as material for paper-making, considerable interest attaches to a communication made by Mr. William Raitt, Cellulose Expert, Imperial Forest Research Institute, India, to the English International Congress of Applied Chemistry. In the article under consideration it is stated that it has been proved that bamboo cellulose is suitable for the manufacture of paper, especially for the printing and litho grades, provided its isolation has been successfully accomplished. Previous to the investigation with which the article deals, some divergency of opinion existed in regard to the possibility of utilizing nodes and certain operations connected with isolation.

The writer refers to Mr. R. S. Pearson's work in connection with the species of Bambusa suitable for paper-making material in India and Burma. Out of some hundred different species, only five were found to be suitable, namely, *B. Tulda*, *B. arundinacea*, *B. polymorpha*, *B.* (Cephalostachyum) *pergacile*, and *B.* (Meloconna) *bambusoides*. These are the only species which exist in commercial quantities and under economically exploitable conditions. Though few in number, these species are each so dominant in its own area that they probably represent 80 per cent. of the whole growing stand of bamboo in the country.

The point next dealt with is the difficulty of distinguishing bamboo stems of different ages. The writer then proceeds to consider the digestion of the stems. It is stated that the material has an undesirable tendency to float. Its resistance to penetration and the variation of this in accordance with the size of the chip is indicated. Also there is the variation in this respect in accordance with age, a charge of mixed age being invariably irregularly digested.

A bamboo column is light and buoyant solely because it is hollow. Its component wood is really as heavy as many of our commercial hardwoods. Its actual specific gravity varies somewhat with species, that of the lightest of the five species we are concerned with being ·8'410 for internodes, and ·8,091 for nodes, while the heaviest is ·9'555 for internodes, and ·9'170 for nodes. Bamboo is therefore of about twice the specific gravity of the common pulp woods, spruce and fir—a fact which when realized in all its bearings, throws considerable doubt as to whether we have been right in treating it on similar lines as wood so far as its preliminary preparation for digestion is concerned.

A marked microscopic feature of bamboo is the large vessels which run continuously from top to bottom of the stems. These do not collapse in drying, but retain their full size and shape, and consequently their air-carrying capacity. Dry bamboo is therefore largely impregnated with air in a state of capillarity—a condition which makes it somewhat difficult to expel, and which fully accounts for the tendency to float, which is one of the chief difficulties in its digestion. Digestion difficulties are therefore due to resistance of the capillary air and to a mass of structural resistance to penetration of liquor varying with the size of the individual chip. The smaller the particles and the more regular their size, the better will be the results. Some light is thrown upon resistance by chemical examination of the stem. It was found that lignification begins with the sprouting of the branches, which occurs

when the culm is three-fourths grown, and is complete at one year old, little or no change in this respect happening afterwards. At the half grown stage, the plant is wholly pecto-cellulose in character. With the rapid increase in lignin at maturity, there is a corresponding reduction in pectose, but with advancing age a gradual increase in the latter at the expense of the starch group. The plant is distinctly of a pecto-ligno-cellulose character.

The investigation into the amount of caustic soda needed for digestion showed that the whole stem, nodes included, when suitably crushed, will digest satisfactorily with a theoretical 17½ to 18 per cent. of caustic soda, and it makes no difference whether it is one or three years old; and in the produce there is absolutely no indication whatever of the nodes. It is pointed out that under normal conditions of digestion, pectose gelatinizes, and probably resistance is set up; but crushing counteracts such action in the case of bamboo.

One of the remaining difficulties is connected with the starch content of the plant, and its effect upon yield of cellulose and also on the bleaching results. It was found that starch in the bamboo is capable of being oxidized by air and dispersed in the atmosphere, and that such oxidation is an integral part of the process of seasoning. This has led to the conclusion that the maximum yield of cellulose can only be obtained from bamboo which is not merely dry, but is also seasoned. The influence of the starch content upon bleaching is due to the results of the combination between it and caustic soda which occurs under the digestion condition of strong liquor and high temperature. This does no harm if it were not for the fact that the secondary starch contains an insoluble dark-brown precipitate, which is unbleachable within economic limits. This was removed satisfactorily by means of the sulphite process. A 1-per cent. solution applied in simple cold steeping to the unbleached pulp produced by caustic soda, dissolved out of it a large quantity of dark-brown colouring matter, leaving it several shades lighter in colour and much more bleachable.

In conclusion, the objections that have been made to bamboo as a paper-making material, and the difficulties hitherto met in their treatment as described in the above article can be met in the following ways :—(*a*) seasoned bamboo only to be used ; (*b*) raw material to be crushed ; (*c*) water soluble matter to be extracted previously to digestion ; (*d*) digestion with sulphite liquor. It is pointed out that the foregoing refer only to the five species of India and Burma, and may not prove altogether applicable to the bamboos of other species grown elsewhere.—The Agricultural News.

MANUFACTURE OF PAPER PULP IN MYSORE.

Investigations into the practicability of the manufacture of paper pulp in the States are being proceeded with in several directions. The Forests have been explored for suitable raw material by special officers deputed for the purpose and a qualified technical expert, Mr. Raitt, has been engaged to conduct tests on samples of grasses and bamboos locally available. With a view to arrive at an estimate of working costs under factory conditions an

agreement has been arrived at with one of the factories in India to get paper manufactured out of 20 tons of crushed bamboo sent from Mysore.

The resources of Mysore both in grasses and bamboos appear to be ample for the manufacture of pulp on a commercial scale. The Mysore District is specially rich in large grass areas and eight forests of an aggregate extent of 456 square miles have been explored during the year. The forests can be conveniently divided into two main blocks of 245 and 211 square miles each. The first block has Nanjungud as a central place, and Manchegowdanahalli on the Mysore-Manantoddy road is a convenient site in the second block.

About 31,000 tons of Mudehullu, Bevinhullu and Doddahanchihullu that are reported to be suitable for pulp are annually available in the first block. The grass can be delivered at Nanjungud at Rs. 15·00 per ton. The resources of the second block in grasses of this variety are about equal, but the cost of delivery at Manchegowdanahalli is less, being only Rs. 9·00 per ton. Besides the grass, the second block that comprises the forests on both banks of the Kabbana yield an annual supply of 30 lakhs or 15,000 tons of bamboos (*Dendrocalamus strictus*). The laboratory tests on the grasses are satisfactory and the results are pronounced to be well within economic commercial limits. Unfortunately the localities in which they are found are not associated with the necessary manufacturing facilities. Manchegowdanahalli is 38 miles from Mysore and the fuel supply does not promise to be adequate.

None of these difficulties are met with in the case of the bamboo. A careful investigation into the resources of the Shimoga forests has revealed that 28,500 tons of thin bamboo (*Dendrocalamus strictus*) can annually be landed at Shimoga at a cost of 9-4-0 per ton. The required quantity of firewood is available at 5-8-0 per ton and water facilities from the Tungabhadra are of course ample.—ANNUAL REPORT, INDUSTRIES AND COMMERCE COMMITTEE OF THE MYSORE ECONOMIC CONFERENCE.

EFFECT OF PALM OIL CAKES UPON MILK PRODUCTION.

J. HANSEN.

The writer concludes from a critical review of the experiments made by other workers and from the results of his own experiments that palm-oil cake does not affect the milk yield, but increases its fat content. He considers that this specific action increases with the increase of the amount of the cake contained in the ration and with the quantity of fat in the palm oil cake itself. In order to obtain a perceptible specific effect at least 2·5 to 3 lb. per 1,000 lb. of live-weight should be used, if the cake is somewhat deficient in fats (i.e containing under 6 per cent. of fat) or 2 lb. per 1,000 lb. of live weight if it is rich in fats (i.e. containing about 12 per cent. of fat).

The effect of the palm oil cake varies with the individual cows, but is in every case perceptible when the cake is fed in sufficient quantities. Neither the milk yield nor the period of lactation when the palm oil cake is introduced into the rations seems to have any influence upon its action.

The writer considers an increase of from 0 to 0·14 per cent. in the fat content of the milk to be but small : 0·14 to 0·20 per cent. as average ; above 0·20 per cent. as large. Of the 21 cows which were the subjects of his experiment, 5 showed a small increase in the fat content of their milk, 10 an average and 6 a large one, the maximum being 0·51 per cent.—MONTHLY BULLETIN.

ESTATE WATER SUPPLY.

The origin of water supplies is rain. Rain falling on the ground drains off to a great extent into rivers, lakes, and the sea, but there is a certain amount of soakage from these and from the wetted land into the rocks beneath ; the amount of the soakage and the depth to which the water descends depends on the porosity of the rocks and the number of fissures, cracks, faults, etc., which the strata contain. These underground waters come to the surface as springs by hydrostatic pressure or by descent to the point of outflow, generally determined by a valley or depression cutting across the water-containing strata. The water level of a district is the depth at which the rocks or subsoil are saturated with water, and if the mass is penetrated to this level a collection of water will take place. Such holes are often made and are called wells ; if the water level is at a small depth, the well is shallow ; if at a great depth, the well is deep.

Due to the varying porosity of rocks underground water will flow in the direction of the dip of the more porous strata, or collect there on meeting less pervious strata ; and if the strata has taken a basin form, as it sometimes does due to great pressure from internal causes, there is a collection of water in the basin ; if a bore is made from the surface to the water-containing strata, water will often bubble up or form a jet. Water supplies of this sort are called artesian wells. If the boring of an artesian well is in contemplation the place for the bore to be made is calculated from the dip of the strata. Artesian wells are found in rainless tracts and deserts, which shows the great distance to which water can travel underground from its origin as rain-water, river or lake.

Rain as it descends to earth absorbs into solution and collects by gravity impurities in the air ; when it reaches the surface of the land, impurities there, are washed by the rain water into rivers, lakes, and the sea, and the soakage water is purified according to the depth and nature of the ground through which it passes before coming to the surface again. Soil, gravel and rock are great purifiers of water, as impurities are held back in the finely-divided interstices and act as a filter.

Water supplies are chosen for their purity and volume. The larger the supply required the greater the difficulty there is in getting purity : and then surface water such as rivers and lakes have to be used and a purification system applied, as for example the water supplies of London and Glasgow.

THE IDEAL WATER SUPPLY.

The ideal water supply for a small community is from a deep spring, bubbling clear and sparkling, free from organic pollution, and containing sufficient dissolved mineral matter and gases to make it palatable. Such ideal sources of water supply are not easily obtained in Ceylon and the estate has to fall back on surface water collected in a reservoir called a well, generally shallow, that is under 100 feet in depth. All such sources are open to suspicion as they are easily contaminated unless every precaution is taken to protect the collected supply and the areas around it from pollution.

Ceylon Municipal water supplies, as the supplies for Colombo, Kandy, Nuwara Eliya, are surface water allowed to collect in a shallow basin, generally a dammed-up valley, and precautions taken that the periphery of the miniature lake is kept clean from vegetation and no habitation of the catchment area permitted. Some of these large water supplies are used for human consumption direct or after straining through fine wire gauze fixed on screens, followed by rough sedimentation and syphoning off into the mains. These water supplies are tested regularly for impurities, as a large population is dependent on the sources; when the number of consumers is small continual control of the water supply is impracticable as the control expenses are too heavy. Such conditions are present when the population is too small to have an organised water supply and they have to fall back on the collection of surface water in a series of shallow wells. When the site for the well is chosen so that it is improbable that the sewage from the neighbourhood can gain entrance, it is well chosen, but it is difficult for the layman to know when that is the case, as water with impurities can find its way into the well through devious difficult ways that seem almost impossible. When a well is surrounded by houses and the inhabitants careless of the disposal of their refuse and sewage, the soil in the neighbourhood in time gets thoroughly impregnated with sewage matter and finds its way into the well : such conditions obtained for example in Slave Island, Colombo, where the population is dense and ignorant of sanitation. Many wells had to be closed in Colombo in densely populated areas where the drainage area was saturated with sewage, and the water collected in the wells was found to have on testing all the characteristics of dilute sewage. The owners of these wells think that wells are like wine, the longer they have been kept the better they are able to stand criticism, and fail to understand why they are filled in when they served as water-supplies for their great-grand-fathers, but it is no hardship for these people to have their water supply condemned as a guaranteed water supply is close at hand if they will take the trouble to apply their hand to the city pump a few yards away.

Estate population is on quite a different footing; they have to make the most of the water supply nature has provided for them, fortunately for them the population is not so dense as in a city and they are under the control of the Superintendent, who tries to impress upon them the cleanliness and neatness born in him; this saves the estate cooly to a certain extent from a grossly polluted drainage area, but, having the eyes of a layman only, it lies out of his province to further protect the cooly from a dangerous water supply unless he has expert advice. This has been supplied by the Sanitation Department, which can advise as to drainage area, but no expertness can pass a water without chemical apparatus, the skill to manipulate it, and to report on the results. Many of the waters sent to me for examination are clear and sparkling and yet turn out the worst on examination, while some are not promising to look at but on examination are found to be quite good waters.

The extent of a drainage area of a water supply depends on the nature of the ground and the lay of the land. The nature of the ground means the type of rock, subsoil and surface-soil through which water percolating to a well must pass through before reaching it, if the well is properly constructed no water passes direct into the well through the surface or subsoil, but passes through a certain thickness of rock. In order to obtain

this the well must be surrounded by a wall a continuation of the side of the well 1-3 ft. high and a cement platform of about 10 ft. radius covering the surrounding soil, sloping away from the base of the wall ; the side of the well should be covered with 1-2 in. thickness of cement or a covering of clay down to the depth of a minimum of about 12 feet according to the depth of the soil ; this will force all water entering the well through an efficient filtering layer of soil, gravel, and rock. If the ground is sloping the higher side of the well should have a thicker layer of cement on the inside of the well. The more porous the subsoil the greater is the area from which the well drains the water, and is usually calculated at an area 20 times in radius to the depression of the water-surface in the well caused by a day's use. The surface of the ground water produced by pumping is in the form of an inverted cone, with the apex at the bottom of the well ; the sides are steep until nearing the subsoil, when they flatten out to the horizontal. The velocity of flow of water feeding the well at any point is inversely as the square of the distance, so that if a point is 30 yards away from the well the rate of flow of water to the well is exceedingly slow and allows of thorough filtration ; but it is always safer to look for danger around a much larger area. These conditions are easily carried out when the strata is uniform, which it seldom is, but when it is fissured, cracked, faulted or a line of weakness somewhere due to stratification, dip or some other cause then the filtration breaks down and the fissure, etc. merely acts as a passage or drain to the collecting depot—the well.

An examination of a water-supply is necessary first to say whether the water is polluted or not and secondly an examination of the drainage area to trace the source of pollution if any. When several probable sources of pollution are traced, or to trace the only probable one without digging deep channels in the soil and blasting rocks, certain chemicals in sufficient quantity are sprinkled over the suspected source and washed in with copious supplies of water; if the chemical is found in the well, a connection between the well and the suspected source of pollution is proved. The chemicals used are an alkaline solution of fluorescin, which gives a distinct colour when one part is added to 50 millions of water. Common salt is sometimes used and tested for regularly in the well water for an increase. Kerosene is sometimes used, but when once it gets into the well it is difficult to eradicate. Lithium salt is useful but expensive ; the presence of lithium being identified by the spectroscope, a bright red band forming at a definite place on the spectrum when lithium is present. These methods of identifying sources of pollution have been criticised, as it is argued that the organisms which do the damage are in suspension and not in solution, that therefore substances insoluble in water should be used ; various finely divided substances have been tried, but not with such success as with the solutions mentioned above. Bacteria prodigioneus has been used, being non-pathogenic, rarely found in waters, and gives a distinctive red colouration on growth; it is however difficult to get rid off, once introduced.

POLLUTION OF WATER.

When considering a water supply for domestic uses one must consider pollution and probability of pollution, the amount of matter in solution and suspension which would cause furring in kettle or boiler, and on which depends the amount of soap one is going to use.

Pollution of an organic source is animal or vegetable. Animal pollution is traceable on analyses as the products of decomposition of animal excretions are found in the water contaminated. Urine contains two easily identified bodies, common salt and urea, the former is easily tested for by means of silver nitrate giving a white precipitate with the chlorine ion of the common salt molecule, and the presence of much salt in a water makes one suspicious that there is animal contamination, unless the water is near the sea. Urea very rapidly decomposes into ammonium carbonate, which in alkaline solution and on distillation, gives off ammonia, which can be tested for in a very delicate manner by means of Nessler's reagent. The solid excrement of animals rapidly decomposes on exposure to air into saline or free ammonia, which in alkaline solution is driven off on distillation. The portion partially decomposed and undecomposed called albuminoid ammonia requires to be oxidised by boiling with strong alkaline permanganate of potash before it will pass over on distillation as free ammonia. The quantity of free ammonia from the decomposed urine and excrement, and the albuminoid ammonia from the more stable excrement, are estimated by the intensity of colour produced on addition of Nessler's reagent to the distillates, and comparing it with pure distilled water after the addition of a measured quantity of standard ammonium chloride.

The presence or absence of nitrates is also an indication of the pollution or purity of water. Nitrogenous organic matter in solution in waters passes into the nitrate state by taking up oxygen by a bacterial process, so that when nitrates are present in a water, an indication is given that the water has been polluted and oxidation to innocuous nitrates has taken place, if free and albuminoid ammonia are also present it indicates that nitrification is not complete and that there is still danger from the pollution. An organically pure water with nitrates indicates past pollution and that an efficient form of purification has taken place from the point of pollution to the point of collection ; grave danger lurks in such water for although it may be efficiently filtered and purified for the present, the filtering medium may break down at any time and the water again become polluted. This happens after heavy rains when a fissured rock which has been acting as a filtering medium gets cleaned out and then acts as a pipe leading from the place of pollution to the place of collection.

The nitrates indicates either an inefficient supply of oxygen to oxidise the nitrogenous organic matter or the reduction of the nitrates by the excess of organic matter. The presence of nitrites makes an Analyst very suspicious of a water especially if the analysis is unsatisfactory from other points of view.

The mineral matter dissolved in a water should not amount to more than 50 parts per 100,000. Magnesia salts should not amount to more than 10 parts per 100,000, owing to the laxative effect, lime having the opposite effect should not be in excess. As most of the Ceylon and Tropical waters where there is a good rainfall as in the cultivated areas are generally soft waters, it is not necessary to discuss all the probable constituents to be found in solution in waters. Suspended matter, being visible, forms the usual complaint about waters used for human consumption and industrial purposes, a light flocculent ferruginous deposit often giving trouble ; this can easily be removed by rough filtration through a layer of sand.

VEGETABLE MATTER IN WATER.

When vegetable matter is in excess in a water, the albuminoid ammonia is present in large quantity, and the free ammonia, chlorine, and solids are generally low. Nitrates are generally absent. Waters with vegetable matter can have a larger proportion of albuminoid ammonia than other waters without creating suspicion, but there is danger to people drinking the water who are not accustomed to it, this may be said of all waters which are not pure, and even of people accustomed to the water who are not in their usual health. This is often demonstrated by people going to live in the country during the hot weather especially at farm-houses in Europe where the usual occupants have received no ill-effects from the water supply but the new comers develop enteric, diphtheria, etc., often due to inflow of sewage matter into the water supply from cess-pools, drainage from fields manured with animal refuse, etc. Water collected in the coal measures are usually high in albuminoid ammonia and cause summer diarrhœa in visitors to the district.

Great stress was at one time laid on the determination of the organic matter in a water by ignition of the solids, this laborious method has been superseded by the determination of the amount of oxygen absorbed from permanganate of potash in presence of sulphuric acid. The figure obtained is useful as an additional test in determining the purity of waters, but is more used in examination of sewages where the determination of organic matter is of great importance, especially its stability, and its resistance to oxidation.

Determination of the dissolved oxygen is another useful extra factor, a fully oxygenated water being very palatable, but this determination is hardly necessary in household waters, as water supplies are easily saturated with oxygen even by handling. Examination of sewages is rather different in this respect as the more oxygen contained in the water the more chance there is of noxious bodies being broken down.

The sediment of a water when collectable should always be examined microscopically, the nature of the sediment will give valuable evidence as to the source of pollution if any.

ANALYSES OF WATER.

A few examples of analyses of water will assist in explaining what is a condemned water and a pure water.

Parts per 100,000.

	Colombo.	Suspicious.	Bad.
Total Solids ...	5·0 ...	30·0 ...	50·0
Free Ammonia ...	nil ...	0·0030 ...	0·012
Albuminoid Ammonia ...	0·0045 ...	0·010 ...	0·024
Chlorine ...	0·6 ...	3·0 ...	8·0
Nitrates ...	nil ...	0·5 ...	2·5
Nitrites ...	nil ..	trace ...	present

It must be remembered that analyses showing so much chlorine, free ammonia, etc., is only an indication that pollution has taken place; the actual amounts of these substances are not poisonous in themselves but they serve as an indication that the germs are present to do their deadly work. Analyses are not infallible in a decision, but if a water is condemned on analysis one can be certain that it is not good for human consumption; but delicate as water analysis is a water may have such minute traces of

sewage in them that it may be passed as fit for human consumption after analysis. A bacteriological test is more delicate even than delicate water analysis as the germs procured in the sample can be multiplied many times and the trace then becomes a workable quantity, but the objections to bacteriological tests are that they take a long time to make, the tester prefers to take his own sample, and it is necessary, otherwise there is no certainty that germs have not entered the sterilised bottle when taking the sample. A water analysis is made fairly quickly and there is not quite the same danger in taking the sample as for a bacteriological test, although every precaution must be taken when the sample is procured as analysis of water is a very delicate operation. Preferably a sample of water for analysis should be sent in a Winchester Quart which has been previously cleaned with acid and copious quantities of water and securely stoppered with a glass stopper. Many samples of water are received in a whisky or medicine bottle stoppered with an old cork, these are rejected as being an improper sample, and a proper sample called for. Samples of water should always be taken under the worst possible conditions, preferably after a heavy shower of rain after a drought ; one may be certain then that any pollution of the drainage area will be washed into the well if there is not sufficient filtering medium. Samples should not be taken during dry weather or during the rainy season unless the supply is being tested under various conditions. In the former case it is only the deeper seated well filtered water that is reaching the well, in the latter any pollution has been diluted out of recognition. Waters which are clear during normal weather conditions and become muddy after rain are specially dangerous, as it shows that the filtering layer of soil from the surface to the inlet in the well is not sufficient. Samples should be taken when the water is muddy.

A report on a sample of water does not, if the sample has been passed, state that it passes for all time, but really only refers to that sample. The next day the water might be polluted. Waters which are polluted intermittently are the most dangerous, as a water might be tested a dozen times and each time be passed and yet not be pure, so it is necessary to impress upon the sampler the urgent necessity to take the sample of water requiring testing under the worst possible conditions.

FILTERING.

When an Estate has had all its convenient sources of water condemned it will be necessary to treat the water to a purification process before using. Filtering is the usual mode of purification but care must be taken that an efficient filter is used. Chatty strainers and charcoal filters are condemned. There are a large number of domestic filters on the market which have been well reported on and from which one can make a choice. The filter should be cleaned out once a week or ten days, by scalding with hot water, the candles should be boiled and brushed if necessary, the cleaning of the domestic filter should be supervised else the servant is apt, to lay the clean candles down on a dirty place contaminating them again, a wine-glassful of lime water per gallon is a useful addition to the water to be filtered as tropical waters are so poor in lime, it also adds to the efficiency of filtration. Filters to treat large quantities of water for estate water supplies are on the market, the filtering medium being a column of sand or flint, the particles of which are of special diameter, a thin filtering skin on the surface of the sand

is made by the action of burnt lime on alum or ferrous alum (Green Vitriol and alum) which forms a gelatinous membrane through which the water has to pass; to clean the filter the flow of water is reversed, the cleansing water passing out by a bye-pass, which when clear is stopped, a fresh filtering skin is formed, and after passing some water through and running it out by the bye-pass is again ready for use. If a filter is not at hand it is advisable to boil the water, which is then safe but unpalatable, but can be made more palatable by shaking it when it rapidly absorbs oxygen, the cooler the water is the more oxygen it will absorb.

When a well has become contaminated and the source of pollution has been detected and stopped instead of allowing the well to cleanse itself, it can be effected quicker by giving the well a thorough cleaning by pumping out the water and allowing fresh water to pass in. Quicker cleansing may be obtained by addition of permanganate of potash until there is a permanent pink tint given to the water. Burnt lime added to a well quickly subsides carrying all suspended matter to the bottom, the lime lying at the bottom of the well will do no harm to subsequent supplies and it would not be objectionable if a cwt. of lime were turned into every well, as it would gradually pass into solution and hasten the settling of suspended matter.

Another method which in part action is similar to the lime purifier is the addition of bleaching powder or calcium hypochlorite, which in dilute solution gives off hypochlorous acid killing the germs and the lime acts as a precipitant. The objectionable smell and taste pass off in a night. Twenty-five pounds per million of water is about the proportion. This can be calculated knowing the diameter of the well and the depth of water.

The formula

$$\pi r_2 h$$

will give the volume of the cylinder of water in the well

n x 12 ft. (depth of water) x 3^2 ft. (radius of well)

3·1415 x 12 x 9 = 339·3 c. ft.

= 2110·4 gallons

= 21,104 lb.

A little less than 10 ounces of chloride of lime made into a thin cream in a bucket and poured into the well giving a mix with the lowered bucket, would be sufficient for a well of above dimensions.

A rough filtration through a box of clean sand with 5 % burnt lime added is advised for water to be used in rubber-factories, as some waters are slightly acid and create premature coagulation in the collecting cups and buckets. Suspended matter, included in the prepared rubber is detrimental to the appearance and price, is also removed by this rough filtration.

Waters may have a source of pollution which is difficult to remove. The contamination may be due to manured fields or trees, these cases are difficult to deal with, the trees may be removed and fields manured with mineral manures, such as Nitrolim, Basic Slag, Sulphate of Potash, the two former have been heated to a high temperature and are unlikely to contain any pathogenic germs due to subsequent contact, sulphate of potash has come from deep mines and after careful preparation is exported so there is little chance of it containing dangerous germs. Cattle manure, blood-meal, fish-manure or other matters of animal origin should be avoided for even if they have been manufactured they are still liable to be dangerous on their decomposition.

POLLUTION OF WATER THROUGH TREES.

A curious case came before me some years ago showing that trees could pollute a water supply and I have obtained permission to publish the results of the investigation from MR. BROCKMAN of Owilakande Estate, Matale. The following are extracts from the correspondence :—

"All around and above the spring there is a reserve jungle of about half an acre to preserve the spring. In this jungle there are several of the following trees :—Kottakebula, Rukettana, Gooranthie. The Singhalese say all these trees are bad for water particularly "Gooranthie."

"Gooranthie did not smell much in a dry state, but when dipped in water becomes offensive."

"If contamination is not due to these trees then it must be at a distance and the only possible is Asgiriya Estate, 2½ miles as the crow flies."

"There are very few houses or dwellings on Pansilatenne—Owilakande Range, and they are mostly on the other side from us."

After this evidence had been led as to the probable source of pollution and the barks of the above trees had been tested, it was considered necessary to remove the trees. The following analysis shows the original analysis condemning the water supply and subsequent ones showing the improvement. It will be noted that it took over 3 years to cleanse the drainage area from its undesirable properties derived from the trees.

Parts per 100,000.

	1910.	1910.	1911.	1914.
Total Solids ...	26·0	16·0	6·1	12·0
Chlorine	3·5	1·6	1·8	1·3
Free Ammonia	0·240	0·070	0·0066	nil
Albuminoid ammonia ...	0·120	0·0180	0·0060	nil
Nitrates	4·0	1·0	2·0	nil
Nitrites	much	much	present	nil

The last sample was passed as fit for human consumption.

WATER TANKS AND PIPES.

In making a new water tank or laying down water pipes, galvanised iron is most useful but water often dissolves off the zinc giving the waters a metallic taste and leaves a white greasy precipitate, this is specially noticeable on boiling. Zinc is not one of the dangerous metals and no cases of poisoning have been noted from a water supply, but it is not a desirable substance to have in a water supply. Lead is dangerous and is usually found where lead has come in contact with soft water. No lead piping should be used where the water supply is deficient in lime. Lead can be identified after Colombo water has been poured through a foot of lead pipe, which shows its high plumbic solvent power. The action of lead on the system is cumulative that is to say it is not easily excreted but deposits itself in the liver, kidneys, etc., giving the well known symptoms of lead poisoning, if sufficient has been consumed. Lead piping quickly takes on a coating from hard water (that is containing lime) which preserves it from further action, but one should be specially cautious until this film has been formed. Copper from brass, gun-metal, or copper pipes is apt to get into water supplies but there is not so much danger from copper as there is from

lead, as it is non-cumulative, that is the bulk of it is excreted. Copper is often found in Soda Waters due to the action of the carbonic acid on the gun-metal when ærating, if the machine is well tinned the action is stopped. There is danger in drinking Soda-water unless one knows that it has been obtained from a reliable firm in a town or city which is under Municipal control. Many Soda-waters made outside large towns contain both lead and copper, and the source from which the water has been taken is anything but desirable.

New piping of any sort should be carefully watched so as to prevent any dirt getting into them before placing. Piping will often lie by the road side for months before being placed so there is often the chance of the larger pipes being used as a place of abode or shelter by tramps and children playing. Iron pipes are protected from rusting by tar, oil, and hessian which often gives the water a distinctive taste for some time. New pipes should in all cases be well washed out before allowing the supply for human consumption to pass through them.

WATERS FOR INDUSTRIAL PURPOSES.

Waters which are used for industrial purposes should be free from suspended matter, and should not have too much mineral matter dissolved in them. Suspended matter is easily removed by filtration, but the dissolved mineral matter is more difficult to get rid off and means can only be devised after a complete analysis of the mineral matter has been made. If a large proportion of mineral matter is present in a water it is said to be hard; hardness is divided into two kinds, temporary and permanent, the temporary is caused by calcium bicarbonate in solution which is removable by boiling forming insoluble calcium carbonate, and is thus thrown out of action, depositing and causing furring in kettles and boilers; it can also be precipitated by adding the exact proportion of lime water or other alkali necessary to form calcium carbonate from the bi-carbonate, and this latter method is the one used in purifying a water for industrial purposes. A long vertical settling tank of the requisite size is used for mixing and settling. Lime water and often ferrous alum is added in the required proportion. After the calcium carbonate is precipitated the water is free from calcium bi-carbonate, which causes furring in boilers, and the water is drawn off ready for use. Permanent hardness, so-called because it is not removable on boiling, is much more difficult to deal with and is caused by magnesia salts, sulphates, etc. Priming in boilers is due to the permanent hardness. When it is inconvenient to have water softeners other solutions may be added to prevent precipitation. Organic matter, certain organic salts are well known to prevent precipitation, and it is on this basis that many patent articles are made up to prevent furring on boilers. In the cultivated tropical belt there is not the same danger of waters having high total solid figures as in a temperate climate, as the lime has been washed out of the soil by the high rainfall, but occasionally there are limestone outcrops from which waters dissolve out the lime.

WATER FROM DRY REGIONS.

In the arid portion of the tropics where the rainfall is small, lime and other salts are found in large proportion in the waters due to the absence of the leaching effect of high rains. This is noticeable when the analyses of soils and waters of the Northern Province are compared with those of, say, the Central Province, where the rainfall is plentiful. A few analyses are given below of waters obtained from the Northern Province, showing the high proportions of total solids compared with the analyses previously given total solids amounting to 5-20 parts per hundred thousand :

	1	2	3
Silica ...	4·0	1·2	0·8
Magnesia ...	7·2	12·02	9·3
Calcium carbonate ...	38·8	50·06	85·4
Iron and Alumina ...	6·4	1·0	2·2
Sodium Chloride ...	47·05	156·4	157·2
Sulphates ...	Trace	2·7	3·5
Total Solids ...	103·5	224·6	259·6

These waters gave considerable trouble when used for industrial purposes, as the hardness is more or less of a permanent nature.

In the Straits Settlements water supplies have caused considerable trouble. An analyses is given below typical of the brackish peaty waters that have to be dealt with.

Parts per 100,000.

Total Solids	94
Mineral Solids	27
Organic Solids	67
Sodium Chloride	24
Free Ammonia	0·374
Albuminoid Ammonia	0·360
Nitrates and Nitrites	Nil

A water of this nature requires careful treatment before it can be made suitable for domestic use : about the only thing to do is for neighbouring estates to combine to obtain a purifier and draw their supply from that : treatment in small quantities with lime and ferrous alum is hardly workable. For bungalow use and for the labour supply, a purifier not being obtainable, distillation might be the easiest method of treatment as the process is simple, fuel plentiful, and an estate cooly could look after the distillation making sufficient for a day's use. For the factory's use the water might be passed through a box of sand and burnt lime.

The rhyme "water, water everywhere, but ne'er a drop to drink" does not hold good when Science grapples the question. Although some estates are not in a position financially to carry out the suggestions made for a pure water supply, all can make some improvement and minimise the danger to public health, remembering that prevention is always better than cure.

A. BRUCE.

GENERAL.

FODDER FOR CATTLE.

The question of cultivating crops suitable for fodder—particularly in parts of the Island subject almost annually to severe droughts during which the natural herbage is practically killed out—is one of growing importance.

The difficulty is to get cattle owners to realise that such a necessity exists.

In the neighbourhood of large towns Mauritius or water grass *(Panicum maticum)* and Guinea grass *(Panicum maximum)* are commonly cultivated.

The cultivation of these two grasses if properly carried on is very remunerative, as both are in large demand for feeding town horses and cattle. While Mauritius grass is commonly cultivated in the low country Guinea grass is chiefly found upcountry.

In the past the necessity for cultivating fodders has not presented itself owing to the excellent natural pasture—whether public or private—that has been available to stock. Indeed individual owners were so abundantly blessed with property that they raised no objection to their neighbour's cattle grazing on their waste lands areas which bulked largely in comparison with cultivated areas.

Now, things are very difficult, for not only have public and private pastures shrunk almost to the point of disappearance, but large stretches of uncultivated land which at one time were so commonly met with, are rarely met with. At the same time the indigenous population who were content with the coconut palm as a perennial crop, have taken to the cultivation of other plantation products—rubber, tea, etc. The result of all these changes has been that village cattle from being free to roam about and pick up any green food that appealed to them have come to have their freedom so restricted by the fencing-in of land and the law of trespass, that stall-feeding has become a necessity.

The material commonly used for stall-feeding native stock is natural herbage cut and brought from wherever available. In the Western Province it may be a wild grass such as *Panicum refrens*: in the Northern the leaves of a tree such as *Erythrina indica*. In the vicinity of towns, however, we find the two grasses already referred to cultivated for use or sale as fodders. Mauritius grass is grown on low swampy lands, e.g., about Colombo, and Guinea grass at higher elevations, e.g., about Kandy.

Lately a third grass has come into favour, viz., *Paspalum dilatatum* introduced from Australia not many years ago. Though it does best at elevations of 4 to 6,000 feet, it can be induced to grow even in the plains.

These grasses need a good deal of moisture for their successful growth and do not thrive in the drier districts. For such areas we want a drought-resisting plant and the most suitable would appear to be Sorghum (in one or other of its varieties) which is found covering millions of acres in India. There it is cultivated both as a cereal and a fodder crop—in the latter case taking the place of rice in places where the rainfall is scanty. It may be grown either as a pure or a mixed crop; in the latter case along with a legume.

The land should be ready for sowing with the rains. For fodder purposes the seed is sown thick to produce a heavy crop of fine thin stalks. For grain about 8 lb. should suffice if put in rows 12 in. to 18 in. apart, but for fodder 50 to 60 lb. may be broadcasted. The stalks should be cut for fodder when the plants are in flower, that is in about 10 weeks.

The outturn of green fodder per acre under favourable conditions will be 20,000 to 30,000 lb. If continuous cultivation is to be kept up, Sorghum should be rotated, or grown together with a leguminous crop.

The crop may be cultivated on high lands or in suitable fields in place of the short paddy crop, and the fodder could be dried off and stored away for use when pasture is scarce.

Recently the Society has been endeavouring to popularise the cultivation of Durra or Egyptian Sorghum (which is specially suited to the dry divisions of the Island) both as a food and fodder crop. It was tried with success on chena lands in the Hambantota district.

Mr. D. S. Corlett, Manager of the Experiment Station, Peradeniya, who has had experience in the growing of this crop in Egypt, says in a note contributed to the Tropical Agriculturist (April 1914) that the grain is the staple food (for man and beast) in many parts of Africa. It can either be eaten boiled like rice, or ground into flour and made into bread and cakes. As the grain matures the leaves may be gradually removed from below upwards to serve as fodder : or the crop may be grown for fodder only. According to Mr. Corlett 6 or 8 pounds of seed sown for a grain crop should return a minimum yield of 500 lb.

Mr. Amerasekere, Mudaliyar, Magam Pattu, writing about this variety of Sorghum, seeds of which were sent to him by the Society for distribution in the Hambantota district, says, "It grows luxuriantly, being well adapted to the soil and climate, and has created a favourable impression on the minds of the villagers not only on account of its abundant yield but from the fact that it is easier to grow, and easier to separate the grain and grind it. The chief difficulty is in protecting the ripening heads from parrakeets and other predatory birds."

C. DRIEBERG,

Peradeniya, 23rd May, 1915. Secretary, Ceylon Agricultural Society.

PAPAIN.

Since Mr. Macmillan's contribution on this subject to the March number of this journal, Mr. David Pratt of the Philippine Bureau of Science has written a valuable paper on the origin and chemical character of the proteolytic enzyme. The best quality of papain, according to our author, is produced in the West Indies, followed by Mexico and Ceylon, the last of which however produces by far the largest amount of the gum.

Mr. Pratt in the course of his travels has visited Ceylon, and seen for himself the preparation of papain as carried on in the Island, viz., by the village folk of the Kegalle district where the crudest methods are in vogue and adulteration is commonly practised, the most common adulterant being boiled rice.

The local product as described by Mr Pratt is either brown or blackish in colour in the case of the pure gum and a light brown colour where a large percentage of starch has been added ; the former being known to the Colombo broker as No. 1. and the latter as No. 2.

To meet the requirements of London and Hamburg the two qualities are blended.

The information given to Mr. Pratt by the dealers in Colombo that pure light coloured papain cannot be made in Ceylon is of course incorrect, since it is possible to turn out the most finished article by careful attention to details, and this has been done over and over again both at the Government Stock Garden and Peradeniya.

The whole trouble arises, as with citronella oil in the South, in the trade being permitted to be carried on without any supervision and produce of varying quality being accepted by dealers, with the result that papain exported from Ceylon has earned a bad name. If only the manufacture could be controlled, adulteration punished by the authorities, and good quality insisted upon by dealers, there should be no further complaints about Ceylon papain. There is no doubt that most of the adulteration is practised by the middleman who purchases the gum in the villages and re-sells it.

It is stated that at least a ton of high grade papain could be sold every month, if it were available, at prices varying from 2·50 to 3 dollars per lb.

Mr. Pratt's article is however mainly concerned with the analysis of papain with a view to ascertaining its proteolytic or digestive value. For this analysis milk as free as possible from butter fat was selected as the substrate, and samples from Ceylon, Mexico, West Indies, etc., tested ; while the digestive value of the gum prepared in different ways and under various conditions were also investigated. The use of alcohol for obtaining a pure enzyme is recommended but the action of the alcohol should be limited to as short a time as possible. The process as carried out in the experiments was as follows :—20 grains of fresh latex were well mixed with 100 cubic centimeters of 95 per cent. alcohol. A gummy white coagulum was thrown down that was readily collected in a ball. The alcohol was poured off and replaced with 50 cubic centimeters of the same strength. The papain readily crumbled to a fine powder during the second treatment with alcohol. It was then filtered with suction and washed twice with ether to remove a semisolid yellow wax and facilitate drying. The washed papain was dried *in vacuo*, giving a perfectly white powder with a faint characteristic odour ; yield, 3 grams. The time required from latex to dry papain was about twenty minutes.

This sample is said to represent the most active papain that could be prepared commercially. Its manufacture would need a still for recovering the waste alcohol, while the ether treatment might be done by the drug firms themselves.

On the subject of yield Mr. Pratt thinks that under our local conditions a yield of 1 kilogram (2·2 lb.) of fresh latex may be obtained from 5 trees, according to age of plant and maturity of fruit. Fruits two-thirds mature gave 1 kilogram (2·2 lb.) of fresh latex, representing 200 grams (7 oz.) of dry papain. In another test 40 fruits of medium size, averaging 1¾ lb. each, yielded 2·2 lb. latex, or 3 per cent.

Dr. Huybertsz of Kandy who is well known as an authority on this subject and possesses not only the experience as a grower but also of a manufacturer of papain products for medicinal purposes, has kindly contributed the following interesting observations :—

The Philippine Journal of Science for January of the current year contains an exceptionably able article on " Papain : its commercial preparation and digestive properties." The writer Mr. David S. Pratt of the Bureau of Science, Manila, though not conveying anything specially new to us, is yet to be congratulated on producing such an excellent and exhaustive contribution ; and the elaborate tables of analyses showing the proteolytic action of papain derived from different sources arrest one's attention, and indicate

that much time, labour, and patience have been devoted to the chemical and etiological character of *Carica papaya*. The alleged frequent employment of the Papaya by the natives to remove stains, and to intensify colours, comes as a surprise, inasmuch as the practice is not known locally. Therapeutically, apart from the instances mentioned in the article, papain has been considered an important agent in the treatment of cancer, and extensively used as such in Germany. The Sinhalese use it mainly to induce the early, rapid, and painless bursting of abscesses. Papain acts equally well in an acid and alkaline medium, and the late Dr. Modder of the Ceylon Medical Service found it of great value in preparing milk for infant feeding. The flesh of poultry and pigs fed on the ripe fruit is rendered tender and of delicate flavour. Green papaw is credited with antaphrodisiac properties.

It is surprising to find that Ceylon Papain ranks third as regards quality, for if the evidence of a well known American firm of chemists who have long dealt in the product is to be accepted, it should take precedence of all others both for quality and high digestive action, a conclusion which is entirely borne out by local experiments.

It has long since been pointed out that the dark colour assumed by the latex in sun drying is due to exposure to air and light, and also to smoke drying during wet weather, and does not affect the purity of the stuff though it is objected to by dealers. Its blending with light coloured and often doctored stuff is an advantage to the producer though not to the consumer. Pure light coloured papain can be obtained by rapid drying in a hot air chamber, while the putrefaction of under-dried latex can be prevented by treatment with formalin. In the preparation of papain the fruits should not be scarified with *steel* knives, but bone, glass, or a sharp-edged piece of bamboo used for the purpose. Repeated tapping of the same fruit is unsatisfactory, as apart from the few drops of inferior latex obtained, the fruit, after primary scarification, ferments and goes bad. This change is frequently mistaken for ripening, but the fruits have no flavour, taste insipid and stale, and are only fit for the poultry yard.

Papaya trees should be planted 15 to 20 feet apart, and interplanted with some other product, as otherwise they are very liable to develop disease which has been known to wipe out a 6 acre block of closely planted trees in less than a month. Mr. Carruthers, late Government Mycologist, examined, at my request, such an affected area, and attributed the disease to close planting. The yield of papain depends entirely on the fruit-bearing capacity of the trees, and 5 trees of the better sort, yielding a total of 15 or 20 fruits, will hardly produce a pound of dried papain, whereas a single native papaya tree carrying 30 to 40 fruits, has been known to yield a pound of the dry material. Latex obtained from secondary branches, after amputation of the parent tree, is generally weak. As for adulterations, many devices are resorted to by collectors to increase their profits, and this is a truly melancholy feature of the industry. But when local firms are prepared to accept any stuff how could the collector be blamed? That there is an excellent market for expoliting pure papain is undoubted; but to get good material, free from impurities and adulteration, and of the required consistency and colour to suit the demands of the home market, responsible personal supervision in the collection of the raw material and the subsequent drying of it are essential.

C. D.

PAPAYA AND PAPAIN.

The attempt to establish a strain of papaya with self-fertile flowers and with male trees eliminated has been continued. The results give promise of complete success within two or three more generations of papaya. The

examination of 454 trees of the second generation of breeding showed that 95⅓ per cent. of these trees are fruit-bearing trees with perfect flowers. Two male trees were cut off three feet from the ground, and when the new branches came out it was found that the sex had been changed and that regular, perfect flowers, each bearing fruit, were developed.

In addition to breeding work with papayas, the station has investigated the matter of producing papain. It was found that dried papain can be produced at a profit for about $2·50 a pound. Requests have recently been made for 2,000 pounds of the material at that price. A papaya grower on Maui is preparing to produce the material. In experiments at the station it was found that if in the early morning a dozen shallow lengthwise incisions, one-half to three-quarters inch apart, are made in a papaya fruit of good size enough juice will be obtained to make half an ounce of dry papain. Fruits may be tapped on alternate days five to seven times in all. As soon as the fruit begins to turn yellow the milky juice flows less freely. The tapping wounds heal quickly and the fruit is not injured by tapping ; in fact, the flavour appears to be somewhat improved, since a slight bitterness which characterizes the juice is thereby removed. It has been found that the papain is injured if the juice is allowed to come in contact with any metallic substances. The only precautions to be observed are that tapping be done with a glass, bone, or ivory instrument, and that the juice be collected in China or earthenware containers, and promptly dried. From the work along this line at the station it is estimated that papain to the value of $2 can be taken from each tree annually.—Report of the Hawaii Expt. Station, 1914.

PEAS AND BEANS OF BURMA.

Bulletin No. 12 of 1914 issued by the Department of Agriculture, Burma, deals exhaustively with the economic value of these products.

The authors (Messrs. Thompstone and Sawyer) express the hope that as a result of their having clearly defined the various kinds of peas and beans, the confusion caused by making such a minor quality as colour the basis of commercial classification (e.g. "white beans") will be cleared up: and that the bulletin will serve its object as a botanical and agricultural guide to this class of plants.

The note on the poisonous properties of the so called "Rangoon bean" (*Phaseolus lunatus*) is of interest from a local point of view in view of the fact that species of this bean are commonly cultivated in the Island, and that their cultivation is extending as the result of the distribution of seed by the Agricultural Society.

According to the authors there is considerable variation in the percentage of the poisonous principle of the beans but the conditions most favourable to its developments have yet to be investigated. It would appear that the variety of a light brown to red or purple, plain or mottled is the chief, if not the only, type which contains the prussic acid-forming glucosides to any dangerous extent.

The white types are recommended for cultivation by the Director of the Imperial Institute as being less dangerous for consumption, and it is suggested that the amount of prussic acid contained in the beans may depend to some extent on the method of cultivation and the degree of maturity of the bean at harvest.

The Burmans consider the dried haalms a safe cattle feed but when fed fresh, and particularly when in flower, they look upon it as a dangerous food which causes death within 12 hours.

In Burma the beans are eaten boiled or parched, which is probably the reason why they are innocuous.

No fatal results are known to follow the consumption of the beans in Ceylon probably for the same reason, viz. that they are well cooked (boiled or curried) before use.

KILLING TIMBER BY RINGBARKING AND POISONING.

AS PRACTISED IN NEW SOUTH WALES.

Mr. A. H. Farrand, Diddillibah, writes :—When ringbarking was in its comparative infancy in New South Wales, thirty to forty years ago, mostly only box timber was ringed, where it had become too dense to allow pasture to grow. Areas were large and rentals very cheap, so that reclaiming inferior country was unnecessary. The style of ringbarking was sapping, but after a time other methods were tried, such as chip ringing, frill ringing, removing strip of bark around tree, etc., but chip ringing remained in general use. It was thought that sapping, causing the tree to die quickly, conduced to a plentiful and vigorous growth of suckers, and there were no doubt good grounds for such opinion. By destroying the timber quickly one is able to bring the land into use so much more quickly that such very much more than compensates for the extra suckers that it may bring. Ringing being done in the summer, when sap is well up, its effect, when tree has been sapped, is shown in a few days by leaves turning colour ; and slumming of work can easily be detected, but contractors for this style might not now be easily obtained

For some years past in New South Wales there has been a great rush for land, and any small area now made available, within reach of a railway, that can be improved into farming land, commands numerous applicants. Such blocks in almost every case are heavily timbered, and the best and cheapest method of destroying such has become an important matter.

Various liquids for poisoning trees have been put on the market, and poisoning with arsenic has been extensively practised of late years. Arsenical poisoning, like sapping, produces a very quick effect, and when it was first tried in New South Wales the Press was deluged with letters extolling its merits. The experimenter was so elated with its apparent success that he made his deductions without waiting sufficiently long to be fully seized of all the points. Arsenic is applied in a liquid form by pouring it into ring cut around tree from a vessel such as a teapot, and frill-ringing, holding such liquid best, is generally adopted. The poison is at once carried up by rising sap and the top of the tree dies as in sapping, but as such poison does not go below the ringed cut, the bottom of the tree is not affected, and a good healthy crop of suckers soon arrives.

Arsenical poisoning of trees is about on a parallel with sapping. If four cuts are put in tree opposite one another and arsenic applied the tree will die, and if just one cut is put the limbs on tree on that side die, whilst the rest of the tree flourishes, thus showing how arsenic is carried up. The other liquids put on the market had much the same effect as arsenic, and as none of them had any effect below cut into which they were poured, the bottom part of tree still went on producing suckers. After a very considerable experience in dealing with timber in New South Wales in various parts, and many years with the Government, where one of my duties was to inspect ringbarked areas, so that I saw the work being done and years afterwards saw the effect, I would

summarise as follows :—Have work done, whether arsenic is used or not, late in the summer, so that the suckers will begin to sprout in the winter time, when the tree is in its most unhealthy period, as you will then have fewer suckers, and those that do grow will not be such strong growers. Also, if the country is stocked with sheep, they will, in the winter time, keep nibbling at green shoots and so impede their growth, and, in some instances, altogether kill them.

Poisoning with arsenic repays the trouble, but do not make your solution too weak, as the arsenic itself is cheap. The "rise and fall of sap," so generally spoken of, is apt to deceive you, but remember, when the arsenic is applied, the sap is rising, and poison therefore carried upwards, so be prepared to see the tree below the cut still growing. This applies to every poison I have seen used.

Fire sapping is being extensively used in the farming districts of New South Wales. A little earth is removed at the foot of the tree and it is lightly ringed at the bottom, and any small timber stacked around it and burned. This causes the tree to die quickly, and it will burn up when grubbed.—Queensland Agricultural Journal.

THE ACTION OF ANTISEPTICS ON CROPS.

E. J. RUSSELL AND WALTER BUDDIN.

Chemical substances are now being put upon the market for partial sterilization of soils, and this paper is intended to afford guidance to the works chemist, who is called upon to supervise the preparation of such materials. Antiseptics may be used in practice in the following cases :—

(1) Where the crop yield is limited to the supply of nitrogenous plant food, and where therefore an increased production of ammonia in the soil is desirable.

(2) Where disease organisms and other detrimental forms are present, and the micro-organic population of the soil has lost much of its effectiveness in producing ammonia from the nitrogen compounds of the soil. Such soils are known as "sick" soils and are fairly prevalent in certain types of high farming and market gardens. To some extent also sewage sick soils come into this category.

The first case is the simplest in principle, but the most difficult in practice, from the circumstance that it is already provided for by the various nitrogenous manures on the market. Until the antiseptic treatment can be made to cost less than a dressing of a nitrogenous manure, it will have no chance against these competitors.

The second case is more difficult in principle but easier in practice because it is not provided for, and there is a clear field here for the application of antiseptics in practice.

The following is found to be roughly the order of effectiveness of a number of typical antiseptics :—

Class 1.—Most effective. Formaldehyde, pyridine.

Class 2.—Cresol, phenol, calcium sulphide, carbon bisulphide, toluene, benzene, petrol.

Class 3.—Least effective. Higher homologues of benzene (e.g., heavy solvent naphtha), naphthalene and certain of its derivatives.

None of these antiseptics is as good as steam, either in increasing the amount of ammonia in the soil, in killing insect and fungoid pests, or in inducing a good fibrous root development. In all trials, therefore, a steamed soil is included to set the standard of excellence previously unattained by antiseptics.—Rothamsted Experiment Station Report for 1913.

PSORALEA CORYLIFOLIA.

This plant (formerly *Trifolium unifolium*) was recently referred to in the Progress Report of the Ceylon Agricultural Society as having been analysed by the Government Agricultural Chemist at the request of the Secretary, in view of the fact that it was reported by Mr. K. B. Beddewella to have a high reputation as a soil renovator in the Walapane district. Specimens were procured for botanical and chemical examination with the assistance of the Assistant Government Agent, Nuwara Eliya, from a village (Bodiwela) to which the plant (known in Sinhalese as Bodi) probably gives its name.

Trimen in his Flora of Ceylon states that it is found in the dry region, though rather rare, and mentions Anuradhapura and Delft as places where it occurs.

The plant somewhat resembles the guar bean, *Cyamopsis psoralioides*, growing up to about 3 feet in height. The flowers are not conspicuous, and of a purple colour. The leaves when crushed have a characteristic odour, which is not pleasant.

Watt refers to it as a common herbaceous weed found in the plains from the Himalayas to the southern extremity of India. In the Konkan a perfumed oil is extracted from the seeds which are also believed to possess many medicinal virtues. The seeds are said to be efficacious in cases of lepra and leucoderma.

The plant has been established in the Government Stock Gardens in order to admit of a further study of it.

WASTE FROM SAW MILLS AS A SOURCE OF POTASH.

The following note has been communicated to the Board by Mr. C. T. Gimingham, F.I.C., University of Bristol, Agricultural and Horticultural Research Station :—Since the outbreak of war various methods have been suggested for making up, to some extent, the deficiency in our supplies of potash manures caused by the cessation of the imports from Germany. Reference may be made in this connection to recent work on the value of the ashes from hedge-clippings, etc., and from waste forest produce.

In addition to the potash obtainable from these sources there is a very large amount of material, of which little use is made, in the wood-scraps, saw-dust, and shavings from planing machines, etc., produced in enormous quantities in every saw mill in the country. It is true that some of the wood-waste, in particular the saw dust, is saleable as such in certain localities, and it is also true that the percentage of ash in the shavings and saw-dust, especially from some of the imported timbers, is very small. Even when allowance has been made for both these considerations, however, it remains a notable fact that there are vast quantities of wood available for conversion into ash.

1. In many saw mills the wood-waste is already used as fuel, and the ash obtained usually either accumulates in a heap, and incidentally loses nearly all its potash by exposure to rain, or it is given away to anyone who will take it. In some few cases it is sold to a neighbouring farmer at a low price.

The writer has recently examined a number of samples of such ash. Some consisted of comparatively coarse material obtained from gas-producing plants, etc. ; others were flue-dusts from boiler flues and chimneys. Flue-dust is the more valuable material, sometimes containing up to 10 per cent.

of potash, constituting a manure of about the same value as kainit ; it is always obtained perfectly dry, and is in a beautifully fine mechanical condition. The percentages of potash in a few of the samples was as follows :—

		Potash (K_2O). per cent.
Sample No. 4 ...	Coarse Ash : Combustion very complete ...	7·24
,, 5 ...	,, ...	5·08
,, 6 ...	Flue-dust	9·11
,, 8 ...	,, ...	6·35
,, 9 ..	,, Coarser than Nos. 6 and 8 ...	5·89
	Average ...	6·73

2. In other mills a mixture of wood and coal is burned. If wood-ash were a saleable commodity, however, it would in many mills be possible to increase the use of wood in the furnaces.

3. In mills where the wood-waste is not used as fuel the quantity produced is often so great that its disposal is a matter of serious difficulty. Were there a demand for wood-ash, there is little doubt that many firms would find it worth while to instal plants adapted to use wood as fuel either for steam-raising or gas-making. Moreover, in big towns where there are many large saw-mills turning out hundreds of tons of wood-waste every week, it might very well pay to set up special plant for burning the waste for the express purpose of ash production.

In view of these considerations it would seem useful to bring to the notice of both farmers and timber merchants the possibility of utilising wood-ashes, at least in their own localities in place of kainit when potash manuring is contemplated. If even a small general demand sprang up, and the collection of the material could be satisfactorily organised, it is possible that a considerable trade could be done.

With regard to the value of wood-ash and flue-dust obtained from saw-mill furnaces, it is important to remember that since timber is relatively poorer in potash than leaves, bark, twigs, etc., the material will, in the great majority of cases, contain less potash than similar ash obtained by burning the undergrowth and waste of forest and woodland. It will, therefore, constitute a somewhat cheaper and lower grade fertiliser. On the basis of the ordinary price of kainit, ashes, such as those of which the analyses are given, should be worth from 25*s.* to 50*s.* per ton ; and since ash is almost purely a waste product, there is good reason to suppose that it could compete with kainit even in normal times.—Journal of the Board of Agriculture.

VARIETIES OF CASSAVA.

(1) *Bobby Hanson* or *Gordon* is an early variety and matures in nine months. It will give good results in all soils except soils remaining always wet. Grows equally well from sea-level to 2,000 feet elevation.

(2) *Pum-pum* or *Bunch of Keys* is another early variety and matures between nine and twelve months. The holes for this variety may not be more than one foot in length, but may be two feet wide. The tubers are generally short and stout. Hilly or gravelly land suits it better than any other soil. Planting at too great an elevation may result in "tree" and not tuber development.

(3) *Grey Hound* is a variety of considerable growth, many and large tubers. It does not yield as much flour as the two varieties mentioned before. It matures in ten or twelve months Red soil is not the ideal one for it, but it suits best a conglomerate such as brown earth and brown gravel mixed.

(4) *Red Jacket* is a variety of many tubers but not necessarily large. It matures in twelve months. It bears best in gravelly land of brownish appearance.

(5 & 6) *Brown Stick* and *Smalling* are varieties much alike in many ways. They thrive in the same kind of soil ; much humus should be in the soil where these are grown and they give very good account of themselves from a little above sea-level to 3,000 above. The flour and starch yields from these varieties is considered the best. They are later to mature than the other varieties. In dry soils they mature between twelve and fourteen months. In damp soils they mature between fourteen and eighteen months. The Smalling variety is chiefly planted. Its tubers are largest, and while the first tubers never fail to continue their development after they are a year old, other tubers go forth from the first. They seldom lose in weight, however long they are kept before they are lifted.

HOLES, CUTTING AND PLANTING.

Except in the case of the Pum-pum, the holes should not be less than two feet (length) by one foot (width). The depth should be about nine inches. These remarks apply to the stiffer soils. In fine light soils a foot square is sufficient. All cuttings should be close to a node or eye, and need not be more than six inches in length, the plants being shorter where the nodes are not far apart. At this time when there may be much rain about $\frac{1}{2}$-inch of the plant may be left uncovered and these plants should be put in slanting, the tuber-producing end not being more than four inches deep. It is hoped the people will not place more than one cutting or plant in each hole. There is no necessity for more.—The Agricultural News.

THE SYNTHETIC PRODUCTION OF NITRIC ACID.

The recent pronouncement of the German Chancellor, and the statements which have appeared from time to time in the daily Press and in technical journals, respecting the enormous extension in the methods of transforming atmospheric nitrogen into ammonia and nitric acid, which are claimed to have been developed by German chemical engineers, have attracted such widespread attention at the present time on account of the necessary employment of this acid in the manufacture of explosives, that it may not be uninteresting to explain shortly, and in general terms, the main principles of the methods by which such transformation is effected. The actual details of the manufacturing processes now employed in Germany have not been published, and are not likely to be made known for some time to come. But there is little doubt that these processes are in the main merely extensions or refinements of methods already established, and in more or less successful operation, at Odda, Notodden, and Christiansand in Norway, at Legnano, near Milan, at La Roche-de-Dame, in the south of France, and at Niagara Falls. Even before the outbreak of the war, factories for the utilisation of atmospheric nitrogen in the manufacture of synthetic ammonia and nitric acid were at work in Westphalia, at Knapsack, near Cologne, at Spandau, and in one or two places in Austria-Hungary. Similar works have been erected, or are in course of erection, in the United States, Switzerland, and Japan.

Although a considerable amount of British capital has been invested in Norwegian enterprises, no attempts have hitherto been made in Great Britain to utilise the vast stores of potentially combined nitrogen which exist in the air. It has been calculated that the air over a dozen acres contains as much potential nitric acid as is annually exported in the form of Chile saltpetre. The apparent apathy of the British manufacturer is probably due to the circumstance that hitherto we have not suffered to any appreciable extent from any shortage of nitrates or nitric acid, and that, so long as we have command of the sea, we are not likely to suffer for some time to come. But it must not be forgotten that the supply of Chile saltpetre is not inexhaustible. The rich deposits of Tarapaca are already worked out and what is now obtained from the more inaccessible districts of Antofagasta, Toco, and Taltal is of much lower quality. On the other hand, we gather from the Chancellor's statement in the Reichstag that the new industry in Germany is to be protected for at least a number of years, which would seem to imply that the manufacture cannot be worked on ordinary commercial lines. The probable effect of protection would be to limit, if not altogether to destroy, the importation of Chile saltpetre into Germany, and thereby to diminish its price to us unless German syndicates manage to obtain control of the workings.

Another reason for the apparent lack of enterprise on the part of the British chemical manufacturer is the assumption that hitherto the commercially successful working of all such synthetic processes would seem to depend upon cheap water-power, of which this country has no very ample store. But it may be doubted whether this advantage is altogether insuperable, at least under certain conditions. At all events, it is certain that the German engineers have to look to other sources of energy. What will be the ultimate effect on the price of nitric acid remains to be seen. In the meantime, it is probable that its present cost to Germany is far higher than to us.

The new methods of making nitric acid from atmospheric nitrogen are twofold in character; either direct, that is, by the direct combination of nitrogen and oxygen, or indirectly through the intermediate production and subsequent combustion of ammonia. The direct formation of ammonia by the union of its elements, nitrogen and hydrogen, has frequently been attempted, but hitherto with very limited success. It has long been known that small quantities of ammonia may be formed by the action of high temperatures, say by the passage of electric sparks, on a mixture of hydrogen and nitrogen. But the reaction is necessarily incomplete, since it belongs to the class known as reversible, and in ordinary circumstances the yield of ammonia is wholly incommensurate with its cost. But it was found by Haber that when a mixture of 1 part of nitrogen and 3 parts of hydrogen, under a pressure of 175 atmospheres, is heated to about 550° in presence of a catalyst, about 8 per cent. by volume of ammonia is formed, which may be isolated by passing the products through a refrigerating apparatus, the uncombined gases being returned to the compression chamber.

The catalyst first used by Haber was osmium, a comparatively rare metal belonging to the platinum group. Later, finely powdered uranium was employed. Much experimental work has been spent in the effort to find other and cheaper catalysts, in studying the influence of temperature and pressure upon the yields, and in overcoming the technical difficulties inseparable from the construction of apparatus of large size capable of withstanding such high pressure as, say, a couple of hundred atmospheres.

The nitrogen is obtained from the air by the use of a Hampson or Linde liquifying apparatus, and subsequent fractionation on Claude's system; the hydrogen is made by passing steam over red-hot iron or heated

coke. The ammonia is converted into nitric acid by oxidation under the influence of a catalyst. The same principle is adopted in the method of Ostwald, by which ammonia, obtained from "nitrolim," or, as it is called in Germany, "Stickstoffkalk," by a process to be described later, is mixed with air and passed through iron tubes into a chamber containing the contact-agent. The resulting products are led to a condensing plant, whereby, by suitable arrangements which cannot be here described but are well known, it is claimed that from 85 to 90 per cent. of the theoretical yield of nitric acid can be obtained of a strength and purity suitable for the manufacture of explosives. The Ostwald process has been worked for some time at Gerthe near Bochum, where it is said to have produced upwards of 1,800 tons of nitric acid annually ; but the experience of other countries where it has been in operation has been far less favourable, and it is doubtful whether a single Ostwald plant is now in use outside Germany.

Up to the present time, the most successful of the factories which have been established for the utilisation of atmospheric nitrogen would appear to be that of the North-Western Cyanamide Company, at Odda, on the Hardanger Fiord, Norway. This concern, which is largely financed by British capital, is operated by electrical energy furnished by a water supply capable of producing 80,000 horse-power. This factory and the associated Alby works together produce calcium carbide, and "nitrolim," a mixture of calcium cyanamide and carbon. Pure nitrogen is obtained from the air by a Linde plant driven by a 200 horse-power electric motor, and capable of producing 13,000 cubic feet of nitrogen per hour. This gas is caused to react on calcium carbide (made by fusing lime with Welsh anthracite in electric furnaces) in electric retorts heated to a temperature of 800°. "Nitrolim," by treatment with superheated steam, yields calcium carbonate and ammonia, which latter substance can be converted into nitric acid by combustion, as already stated.

The methods for the direct combination of nitrogen and oxygen to form nitric acid depend upon a reaction first pointed out independently by Priestly and Cavendish upwards of 130 years ago, and further elaborated towards the close of the last century by Sir William Crookes and Lord Rayleigh, who established the theoretical principles upon which the reaction proceeds. They showed that under the influence of a high temperature, produced by electric sparkling, or by the passage of a strong induction current, oxides of nitrogen, and ultimately nitric acid, were formed in notable quantity. Indeed, it was in the course of the experiments which served to establish the composition of water that Cavendish incidentally discovered the true nature of nitric acid. But, as the history of science so frequently reveals, although the fundamental discovery was made by English observers, it was left to foreign technologists to turn it to practical account. This was first accomplished by Birkeland and Eyde in 1903, who established a factory at Notodden in Norway. In their process, air is driven by a Roots blower through a powerful arc flame, operating in a magnetic field, in a specially constructed furnace. At the high temperature of the flame (3,000°—3,500°) about 1 per cent. of nitric oxide is formed, equal to about 30 milligrams of nitric acid per litre. The actual volume of air operated upon in each furnace is nearly 800,000 litres per minute, and in all about three dozen furnaces are in use. The nitric oxide thus produced is rapidly cooled, when it combines with a further amount of oxygen in the escaping gases to form nitric peroxide, which by treatment with water in absorption towers is changed into dilute nitric acid, to be subsequently concentrated or converted into nitrates.

Various modifications in the mode of producing the arc flame, either with or without a magnetic field, have been introduced by German and

Russian engineers, and different methods of absorption and concentration of the acid have been suggested, but the essential principles of the processes are practically identical in all, of which published accounts are at present available.

It will be seen from the foregoing statement that the Germans have by no means an exclusive monopoly in the production of synthetic nitric acid, and there is no reason to believe that the modifications they have been able to make in pre-existing processes not of their own invention have placed them in an independent or greatly superior position. It must be remembered that they are at present driven to work under abnormal and utterly uneconomic conditions and it remains to be seen how far they will be able, as a manufacturing nation, and in face of the world's competition, to make good their boast that they have rendered themselves permanently independent of outside supplies of nitrates. Their strenuous labours, under the sharp spur of necessity, will at least serve to demonstrate what is to be the ultimate future of synthetic ammonia and nitric acid.—Nature.

PLANT FOOD IN SOILS.

The thirteenth of the series of lectures established to commemorate the late Dr. Masters was delivered by Dr. E. J. Russell, of the Rothamsted Experimental Station, at the Royal Horticultural Society's Hall on Tuesday last. The subject dealt with was the production of plant food in the soil.

The lecturer pointed out that the expression "plant food" is open to criticism from the physiological side, but nevertheless it has the advantages of simplicity and of being readily understood by practical men. Further, no equally simple but unobjectionable expression has yet been suggested. The term is used to denote those substances which the plant takes from the soil, and out of which it builds its tissues.

The plant food obtained from the soil is, roughly speaking, of two kinds :—

(1) Substances that exist already formed in the soil, and were part and parcel of the minerals from which it was derived.

(2) Those which were not originally present, but have come in since the soil was laid down as the result of the changes produced by vegetation.

The first beginning of the soil goes back to remote ages, when the particles of sand, grit or clay got split off from the original rocks and began their wanderings by stream, wind or glacier that have finally brought them where now they lie. Many of their properties were determined by these wanderings, and cannot now be altered ; thus some of the most striking differences between the red soils of Devon and the grey soils of Dorset arose out of the differences in conditions between Triassic and Lias times. These differences have persisted all through the ages, and the work of the past cannot now be undone.

But the mineral particles do not constitute soil. The final stage in soil formation is not complete until vegetation has sprung up and died, and its remains have mingled with the mineral fragments and begun to decay. During its lifetime this vegetation took up certain substances from the mineral matter and the atmosphere, and built them up into complex organic matter. Like other construction work, this process requires energy, which in this case is derived from the sunlight and is stored up in the complex substance of the cell tissues.

When the plant dies its remains mingle with the mineral fragments and begin to decay. The whole process then reverses : instead of building-up there is a breaking-down, the fabric of complex material slowly elaborated during life is disintegrated and resolved into the simple substances out of which it was formed, and the stored-up energy is dissipated. The old life is cleared away, and the ground is left clear for new life : the old plant tissues are converted into food for another generation of plants. So prodigal is Nature with life that even this process of dissolution and decay affords the means whereby more life may manifest itself. A whole population of the most varied description springs up in the soil, feeding on these plant tissues, deriving its energy stored up during the lifetime of the plant, and reversing completely the changes effected by the plant.

The soil is the medium in which this second part of the great cycle of life goes on. In some respects the medium and the cycle are so intimately bound up that it is impossible to separate them or to think of the soil apart from the changes going on within it. This is the great distinguishing feature of the soil, marking it off sharply from a heap of mineral matter and bringing it out of the province of the mineralogist into the sphere of the biochemist.

The first obvious change in the plant material after it has mingled with the soil is that it goes black ; this can easily be observed when the leaves are dug into the soil or dragged in by earthworms. The old chemists were very interested in this black substance, and, in the early days of the last century, when men of science were very prodigal with new names for new forces and new substances, they supposed it to be made up of a number of compounds which they call ulmic acid, cronic acid, apocrenic acid, and humic acid. No one has ever succeeded in preparing any of these compounds in any state that would satisfy a modern chemist, and there is no evidence whatsoever that they exist ; but their names have been piously handed down through long generations of students, and they still occasionally turn up in popular articles and examination papers.

It has proved more fruitful to study the fate of the separate plant constituents and ascertain the changes through which they pass when decomposed in the soil. For this purpose the plant substances are divided into several groups : the carbohydrate group, including soft cellulose and gums, the hard resistant fibres made up of resistant cellulose, the proteins, the mineral substances, and the waxes.

Very little is known about the decomposition of the carbohydrate constituents except that it is rapid. Apparently, a considerable number of organisms is able to bring it about : bacteria, moulds, and larger forms ranging up to earthworms, and it appears to furnish much of the energy necessary for the life of the soil population.

The decomposition of the protein has been studied more closely. The first products appear to be the amino—and diamino—acids formed on hydrolysis, but these break down further to yield ammonia. If this were left to itself it would change into the carbonate, a substance which in small quantities can be taken up and utilised by the plant, but is harmful in larger quantities, besides having rather a bad effect on heavy soils, making them very sticky.

But the ammonia is not left to itself. It is at once seized upon by another set of bacteria quite distinct from all others, which oxidise it into nitrite, and this in turn is seized upon by an organism, also quite distinct from any other, and oxidised to nitrate. The decomposition of the protein thus involves two stages, and the production of nitrate, which also involves at least two stages. It so happens that in natural conditions the last stages proceed more rapidly than the earlier ones, so that each set of organisms may be regarded as having to wait for those engaged in the earlier stages. This arrangement seems at first sight wasteful, but it is really advantageous, because it prevents any

accumulation of intermediate products which might be harmful both to bacteria and to plants.

Running alongside of this decomposition is another. The amount of nitrate formed is never as great as one expects from the nitrogen in the protein, and the deficit is attributed to a loss of gaseous nitrogen. We have, therefore, two possibilities : the protein may change to nitrate, or it may change to nitrogen.

Now, the evolution of gaseous nitrogen is of no value whatsoever to the farmer or the gardener : on the contrary, it represents a dead loss, because the nitrogen escapes into the air. It is difficult to exaggerate the seriousness of this loss to the intensive cultivator. One of the Rothamsted plots annually receives the liberal, but by no means excessive, dressing of 14 tons of dung per acre, containing 200 lb. of nitrogen. Of this about 50 lb. is recovered in the crop, and about 25 remains in the soil. Some, also, gets away in the drainage water. But about one-half of the nitrogen cannot be accounted for, and presumably it goes off as gas ; at any rate, the cultivator gets no benefit from it.

It is impossible to form a precise estimate of the losses of nitrogen in a market garden, but the conditions all favour high losses ; still more do they in glasshouses where crops like cucumbers are being grown.

The market gardener is compelled to manure heavily in order to secure heavy crops, and this loss of nitrogen simply represents the extra price that always has to be paid whenever production is forced beyond a certain level. But just as the engineer has learnt how to increase the efficiency of an engine, so the cultivator has to learn how to increase the efficiency of his production processes.

For a long time it was uncertain whether the gaseous nitrogen arose direct from the proteins by a process analogous to combustion, or whether it was formed by decomposition of the nitrates. The problem is not yet solved, but the evidence is steadily accumulating against the combustion hypothesis, and as far as it goes it indicates that the nitrogen passes safely through the ammonia stage, but gets lost afterwards. If this turns out to be correct an interesting method of reducing the loss, if not of preventing it altogether, will become possible. It is obvious that if the ammonia (or the nitrate into which it is converted) is absorbed by the plant, it cannot give rise to gaseous nitrogen in the soil, and therefore the loss will be eliminated by arranging the conditions so as to facilitate absorption by the plant. It has been shown in agricultural practice that absorption of nitrate is greatly facilitated by properly balancing the manures, and we hope for a good deal by adopting the same plan in horticulture. At present horticultural practice is, to say the least, indiscriminate, and there is considerable scope for improvement.

The cycle of change on which depends the success of our crops and our gardens is the work of the soil organisms, but it is hardly likely to be their sole work. Can we step in and control the process, and make the organisms more useful ? The idea of sitting down and directing things instead of labouring to do them has always been one of the laudable ambitions of mankind, and efforts have not been wanting to control the soil bacteria.

The attempt began some 25 years ago, when it was found that leguminous plants could be made to grow on the most barren sands manured only with calcium carbonate, potash and phosphates by the simple expedient of inoculating with the necessary bacteria. Nothing is easier than to put bacteria into the soil, and it was thought that if nothing else were needed, then truly the golden age had come to the husbandman. The desire to get something for nothing is deeply implanted in the human breast, and here seemed

to be fulfilment complete beyond the wildest hopes of the most visionary schemer. Unfortunately, inoculation has not come up to expectations; before it can hope to succeed all the soil conditions have to be made favourable both to the organisms and the plant: drainage, cultivation, supply of calcium carbonate, phosphates, potassium salts, moisture, suitable temperature, depth of soil, all have to be provided for, and by the time this is done the soil has generally been so greatly improved that inoculation is unnecessary. A few successful cases are on record where the necessary organism was presumably lacking from the soil, but they are the exception, and not the rule.

More recently it has been found that the useful organisms are on the whole more resistant to adverse conditions than the useless or harmful ones, and, therefore, that any process of gentle killing or partial sterilization will effect an improvement. Experience is bearing this out, but it is also demonstrating that the process cannot be carried out without considerable trouble. "Truly," says Virgil, "the farmer's path is not an easy one," and in that still older Book the cultivator is told that only by the sweat of his brow shall he earn his bread. Modern science promises no short and easy way of getting round this old injunction. What it has done is to dignify the husbandman's calling by revealing something of the wonder and beauty of the factors involved: it has shown, also, how this labour may be better directed as his knowledge of the forces of Nature becomes more and more extended.—The Gardeners' Chronicle.

REPORT ON SOME ECONOMIC PRODUCTS.

The following information on Lemongrass Oil, Papain, Plantain Flour and Plantain Fibre has been furnished by the Director of the Imperial Institute in reply to a letter addressed to him by the Editor of this journal:—

(a) Lemongrass oil was recently quoted in London "on spot" at $2\frac{1}{4}d.$ to $2\frac{1}{2}d.$ per oz., according to quality, with "shipment" at about $1\frac{15}{16}d.$ to $2d.$ net c.i.f. (May 1915).

(b) Papain was offered at 9*s.* per lb. in London in January 1915. There is but little demand for papain, and the market is easily overstocked.

(c) The sale for plantain flour is very limited. There is little doubt that the flour could be used for many ordinary manufacturing purposes, but it would have to compete with other farinaceous materials selling in London at from £6 to £12 per ton. Prices up to £20 per ton have been realised for banana flour, but it is unlikely that such values would be maintained if large quantities were placed on the market.

(d) The value of plantain fibre is difficult to state, as so much depends on the quality of the fibre, but it may be mentioned that "fair current" Manila hemp, with which good plantain fibre would compete, was recently quoted at from £39 10*s.* to £40 per ton in London (19th May 1915) and from £27 to £28 per ton at the corresponding date in 1914.

The under-mentioned firms of brokers in London would probably be able to obtain offers for consignments of the foregoing products. It must, however, be pointed out that it will be useless to approach brokers regarding the sale of the products unless it is intended to offer them in commercial quantities.

Lemongrass Oil: Messrs. R. C. Treatt and Co., Ltd., Dunster House, Mincing Lane, London, E.C., Mr. W. Naumann, 63, Bartholomew Close, London, E.C.

Papain : Messrs. Lewis and Peat, 6, Mincing Lane, London, E.C.; Messrs. French and Plucknett, 7, Mincing Lane, London, E.C.

Plantain Flour : The Produce Brokers' Co., Ltd., 24/28, St. Mary Axe, London, E.C.; Messrs. Lewis and Peat, 6, Mincing Lane, London, E.C.

Plantain Fibre : Messrs. Wigglesworth & Co., 82, Fenchurch Street, London, E.C.; Messrs. Hindley and Co., 74, Billiter Buildings, London, E.C

EXPANSION OF THE MADRAS AGRICULTURAL DEPARTMENT.

Apparently the Agricultural Department in India is not being hampered by a policy of retrenchment.

We gather from a press note issued by the Government that an elaborate scheme for the expansion has received the sanction of the Secretary of State.

The provision for the employment of a large staff of officers recruited locally, who are to receive adequate remuneration, is an important feature of this scheme which promises well. Such men not only know the country and could serve as intermediaries between the scientific experts and the cultivating classes, but will also have an opportunity of benefiting themselves and proving more useful to their own communities and the country at large by their association with men of higher qualifications.

According to the Wealth of India, the main features of the scheme are the division of the Province into seven distinct agricultural tracts, each of which will be in charge of a Deputy Director of Agriculture, and the improvement in the pay and prospects of the various branches of the Agricultural Service so as to make them not inferior to those of the corresponding branches of the Educational Service. Under the re-organisation there will be three distinct branches of the service—Imperial, Provincial and Subordinate. The Imperial branch will consist of seven Deputy Directors exclusive of the expert and teaching staff of the Coimbatore Agricultural College. The Provincial staff of 14 will consist of Assistant Directors of Agriculture and Assistant Scientific Officers on pay ranging from Rs. 200 to Rs. 700. One of the most interesting features of the scheme is the manner in which the subordinate staff will be organised. The Upper Subordinate Service on the agricultural side will consist of farm managers, teachers at the Agricultural College, and the Senior District Inspectors, and on the science side, of assistants in the Science Sections at the College. The two branches will have a combined cadre of 84 appointments in all, on pay ranging from Rs. 50 to Rs. 200. The Lower Subordinate Service will include assistant managers, Junior Inspectors and fieldmen. It will contain 141 appointments on pay ranging from Rs. 35 to Rs. 90.

There will be the College and Central Farm at Coimbatore and nineteen experimental and demonstrational farms in the chief agricultural tract of the Presidency. There will be at least one upper subordinate in each district with extra hands in the more advanced tracts, and in each division there will be one spare man at the disposal of the Deputy Director for employment on special duties. At the College there will be twenty-two men in these grades, or twenty-four including the engineering and veterinary assistants. The

Lower Subordinate branch will help to man the farms and provide fieldmen in the science sections. Three subordinates will be allotted to each district, and there will be two reserve hands in each division who can be used by the Deputy Director to supplement the district staff where needed, with extra men in each of the three more advanced divisions

The total extra cost involved by this scheme amounts to nearly $2\frac{3}{4}$ lakhs per annum.

THE CULTIVATION OF ONIONS.

The chief objection to thinning onions is the expense. On the other hand, if onions are not thinned, there is likely to be a large percentage of undersized bulbs, and even those that are of marketable size (that is, more than $1\frac{1}{4}$ inches in diameter), are likely to be much smaller than those that have been thinned. The tendency of the market at the present time is to give preference to large-sized onions, so that although the accepted minimum standard size for market onions is $1\frac{1}{4}$ inches in diameter, unless most of the onions in a given lot are considerably above the minimum it is difficult to sell them on some markets, even at a reduced price. Therefore, if onions are to be grown without thinning, great care must be taken in sowing the seed to secure a thin and uniform stand. This involves testing the seed for germinative power, and adjusting the seed drill with extreme precision.

GROWING ONIONS FROM SETS.

On the whole it appears that although the cost of growing onions from sets is considerably greater than growing the crop from seed, the sets are more certain than the seed to produce a paying crop, especially under unfavourable weather conditions; the crop is likely to be larger; it ripens earlier, and can usually be disposed of promptly at harvest time. The chief objection to the growing of onions from sets is the enormous amount of labour involved in planting them. However, this is usually offset by the saving of expense in weeding, thinning, and tillage. The excess cost of sets over seed, and the increased labour of harvesting the larger crop from the sets are usually more than balanced by the greater value of the crop; thus, under present conditions, the growing of onions from sets for local market in Illinois town appears to offer greater opportunity for large profits from small areas than growing onions from seed. The growing of ripe onions from sets may well form part of a general market-gardening business, provided the quantity grown in a given locality does not exceed the capacity of the available markets.—

Bulletin of the University of Illinois Experimental Station.

DEVELOPMENT OF AGRICULTURE IN JAPAN.

Sixty per cent. of the people in Japan are engaged in agricultural pursuits. In 1914 the *area subject to land tax* was 36,356,594 acres divided as follows :—

	Acres.		Acres.
Rice fields ...	7,158,634	Non afforested plains...	3,149,257
Arable land ...	5,980,270	Other lands ...	31,294
Forests ...	19,178 568	Ponds and swamp ...	31,438
Pastures ...	103,679		

The difference between these items and the whole includes the surface occupied by buildings, salt works and mineral springs. On March 31, 1913,

the *total area of forests* (both those subject to land tax and those exempt from it) was 46,318,550 acres, of which 19·5 millions belong to the State and about 4·2 millions to the Imperial Household. At the same time the *mountains and plains not under forest* (both those subject to and those exempt from land tax) amounted to 5,338,202 acres, of which about 323,400 belong to the State and 360,150 to the Imperial Household.

Thanks to the fertility of its soil and the humidity of its climate, Japan is very rich in forests; thus the land under forests or susceptible of being afforested is estimated at 69,706,013 acres, or 73·1 per cent. of the whole area. Up to within a few years ago the forests were not utilised to any great extent, but of late years this utilisation has made great progress. In 1912 the forests of Japan proper yielded :—

		Cubic feet.		£
Timber ...	...	1,008,609,646	...	8,146,960
Bamboos	...	37,713,642	....	257,140
By-products	...	—	...	2,160,332

The value of products derived from wood (charcoal, acetic acid, gum, pitch, resin, lamp-black, wood pulp, camphor and oil of camphor), amounted to £2,691,266. In 1912, 354,289 acres were afforested at a cost of £440,064.

According to the law on forest management of 1907, the Forest Administration is empowered to prevent deforestation and to promote reafforestation. A project for improving watercourses has been drawn up; its execution will require 19 years from 1911. In pursuance of this subject meteorological observatories will be erected in the most important forest centres in order to determine the relation between climate and forests; special grants will be allowed for the reconstitution of national forests, for the reafforestation of waste lands belonging to the State, and for the protection of these against erosion, etc. The area of State property to be reafforested is estimated at about 12 million acres, or 30·7 per cent. of the total area of woods and waste lands.—Monthly Bulletin.

THE FIXATION OF ATMOSPHERIC NITROGEN.

DR. H. C. PRINSEN-GEERLIGS.

The great development in the science of agriculture has greatly contributed to the over-increasing output of crops per acre, while the use of steam ploughs and other agricultural machines, the rational rotation of crops, the selection of adequate varieties, the combatment of pests and diseases has also increased the outcome enormously. The instances in which incredible amounts of product are reaped from small plots of land, specially in the case of garden truck and fruits, are numerous and show how the land can be induced to bear extraordinary amounts of produce.

This fact is a very hopeful one and apt to inspire confidence in the future, contrary to the pessimistic views pronounced now and then to the effect that ere long the steadily-increasing population will outgrow the means of existence and thereby have to suffer famine in the long run.

When, however, we examine the requirements which cause the big returns, we see that copious fertilization is one of the chief factors of the opulence and next, that at least one of the manuring units, the nitrogenous bodies are used to a great extent and in fact, are indispensable to its obtention.

The greater part of the nitrogenous matter, however, is derived from layers of guano and saltpetre or from coal, which all have taken thousands of years to be formed and are now very rapidly used up without restoration of the loss. In these times of great progress in agriculture we are rapidly living upon the capital hidden in the soil, which is not renovated and may become exhausted some day. The layers of guano have already almost totally been disposed of, and every now and then we hear predictions about the time when, at the present rate of exportation, the saltpetre mines in Chile will cease to yield their precious product. It is true that notwithstanding the yearly increasing output of the Chilean saltpetre fields the date at which they will have become exhausted is delayed every time, so that the term is now being put down at fifty years from hence, while fifteen years ago the time to elapse dating from that year was still reckoned at thirty years. But anyhow, even if the term may be again prolonged by another score of years, there certainly will come a day, when those accumulated riches are no more available and will have had only a temporary influence on the world's food production.

The second source of industrial nitrogenous bodies is the coal from which ammonia may be obtained on its being turned into coke. The nitrogen of the huge amounts of coal consumed now in the hearths and furnaces is completely lost, while in the common coke distilling process no more than 15 per cent. of the nitrogen is recovered and the other 85 per cent. goes to waste. The Mond coking process, with superheated steam, is much better in this respect, as it causes no less than 70 per cent. of the ammonia to be obtained. It is, therefore, true that still immense quantities of nitrogenous combinations might be won which now are squandered, so that in case of emergency much might be done to supply our wants if the saltpetre is no more available. We ought, however, not to forget that in every case the ammonia is only a very insignificant by-product of the coal and that it only pays to gather it because the coal itself is used for useful ends. If now we find a good substitute for coal in some form or other, be it water power from waterfalls, sunheat utilization, use of oil for fuel, fixation of the force of the tides, so that the necessity of digging coal is no more felt, this source of combined nitrogen is at the same time stopped even if the earth still contained enormous amounts of good coal.

The danger of our supply of nitrogenous bodies coming to fail us one day or other in a not too remote time, has induced the famous British chemist CROOKES to urge, in a speech delivered some twelve years ago, that every effort had to be made in order to find a good process of fixing the nitrogen of the atmosphere, as this was the most necessary means to prevent our race losing the advantages reaped now by the advance of science. The excellent results obtained by agriculture now reposed on annihilation of existing soil capital and were sure to fail one day, while as soon as it was found possible to fix the atmospherical nitrogen the supply of nitrogenous bodies for our production of foodstuffs will become inexhaustible, and progress can go on indefinitely.

The inorganic constituents for the plant production are to be found in the earth in untold masses, the carbon, oxygen and hydrogen which build up the organic matter are derived by the green cells of the plants from the atmosphere, but the plants cannot, as a rule, assimilate the free oxygen of the air. They want combined nitrogen in the form of ammonia or nitrates, and if now we are able to turn the free atmospherical nitrogen into those combinations on a technical scale, our necessities for production of plants are unlimited as well in this time as in times to come.

Already very soon after CROOKES' speech nitric acid was made on a large scale from the nitrogen and oxygen of the atmosphere, and that by forcing air through a chamber in which a very powerful electric arc lamp burns in a

magnetic field. By the action of the magnetism the flame is flattened so that it yields a good contact with the air passing along it and under the influence of the electric flame a few percents of oxygen and nitrogen combine into nitrogen oxide. The mixture of the unchanged air and its small percentage of nitrous gases are conducted over towers in which water trickles down, which converts the oxyie into nitric and nitrous acid. After having passed two towers moistened with water, the gases pass a third one in which milk of lime is used to catch the last traces of nitrous compounds, which change them into calcium nitrate and nitrite. The last solution is exposed to a heavy pressure by which also the last traces of nitrite oxidize into nitrates, so that the whole amount of combined nitrogen has passed over into the form of nitric acid or its lime salt. The nitric acid solution from the first towers is saturated with limestone, thereby forming calcium nitrate. The solution is evaporated to dryness and the dry residuum sold as calcium nitrate or, according to the country in which it has first been made, Norgesaltpetre.

A second method of fixation of atmospherical nitrogen is the heating of calcium carbide in a current of pure nitrogen gas. The carbide is made in an electric furnace from coal and lime and after it has cooled down to a certain temperature a current of pure nitrogen gas is conducted over it, whereby it changes into calcium cyanamide. If this preparation is distilled with water vapour, it gives up its nitrogen content in the shape of ammonia, which may be captured in some way or other. It is not even necessary to treat the cyanamide with vapour, but when put into the soil in a finely powdered state, it gradually is transformed in such a way that the nitrogen is liberated as ammonia and becomes available for the rootlets of the plants.

In a third method a current of nitrogen gas is conducted over aluminium carbide, which had previously been prepared in an electric furnace from aluminium oxyde and carbon. The re-action which follows turns the aluminium into aluminium nitride, while a current of carbon-monoxyde escapes, which may be used as fuel. The aluminium nitride in its turn is transformed into aluminium oxyde and ammonia, of which the former may be used as a raw material for the manufacture of metallic aluminium, while the latter is our nitrogenous material, which we wanted. In all these instances the nitrogen of the atmosphere is induced to enter into combination by bye-paths and under application of much energy or heat. In all the cases mentioned that energy has been derived from the force of waterfalls, which is as inexhaustible as the atmospherical nitrogen itself and which is the best instance of the application of natural supplies which are everlasting and do not use up the limited supplies laid aside by nature.

A new method, which is based on quite another principle is the direct combination of nitrogen and hydrogen under pressure at somewhat elevated temperature and in presence of a catalytical matter. Under favourable circumstances a mixture of both gases mentioned will combine to a very small percentage, while the reaction does not go farther, as it is reversible and will cease as soon as a certain equilibrium is obtained. The mixture of gases is cooled to a low temperature at which the portion of ammonia formed becomes liquid and may be tapped off, or it is conducted through sulphuric acid which absorbs the ammonia, while the remaining mixture is conducted back into the condensing room, where a new portion of ammonia is formed from the elements, and so the whole of them may be linked together to form ammonia.

It is necessary that the gases are pure in order to keep the catalytical force up and it is evident that such processes require enormous installations to be put to profit. The pure nitrogen is ordinarily made by fractioned distillation of liquified air, by which separation the pure oxygen may also be

recovered and put to profit. The methods for making pure hydrogen are being steadily improved, and it is certain that in the long run those gases will be made much cheaper than nowadays.

In this moment the methods for the fixation of atmospherical nitrogen are still in their infancy, and out of the over 4·5 million tons of nitrogenous bodies yearly used in the world, only 450,000 tons or 10 per cent. have been obtained in this way, while the balance still hails from the saltpetre mines and the cokes and gas works, but there is every reason to believe that the tables will turn. We see now, that after the supply of Germany with Chile saltpetre has been stopped by the blockade, the manufacturers of that country have gone to work with energy and have succeeded in rendering themselves independent of the foreign supply by making their nitrogen compounds themselves in hurriedly equipped establishments.

The ammonia and the saltpetre may be used as fertilizers and be turned into albuminoids by the intermediary of plants, which serve as food for man and animal. In most cases we are bound to time, climate, conditions of growth and so on and in every instance the transformation is a slow and risky one. In the last months, however, under the pressure of the extraordinary times, it appears that the German Fermentation Industry Institute has found a means of converting the nitrogen of ammonia into albuminoids in a very short time and quite independent of climate or temperature. When allowing yeast to grow under certain circumstances in a liquid containing sugar, ammonia sulphate and some nourishing salts, and by forcing a current of air through that liquid, the yeast is induced to grow very lively and to form a great deal of organic matter. The dry substance formed is equal to the weight of the sugar employed and about 40 per cent. of the dry substance formed thus consists of albumen. It is already practised since a long time to feed cattle on dry yeast, which by the drying process has lost its fermentive properties and forms an excellent fattening material. When mixed with molasses it forms a complete food, containing every element for the production of meat, fat, butter, milk, hides, horns, etc., which by the combination of the two methods may, as far as concerns the organic substance, be totally derived from the atmosphere. We see, therefore, that it is really possible to obtain all plant and all animal matter on an unlimited scale from inexhaustible supplies, after methods which as yet are still very incomplete, but will not fail to become improved and will be able to procure all the nitrogen compound desired without having need to take recourse to the soil's capital.—
The Louisiana Planter and Sugar Manufacturer.

SOME POINTS ABOUT MULCHING.

H. E. KEMP.

There are but few crops which are not benefited to some extent by the judicious use of a good mulch during the hottest months of the year, but fear that in many cases mulches are employed too early in the spring, so that instead of benefiting the crops they do more harm than good. The chief reasons for applying a mulch are (1) to check evaporation of moisture from the soil and to prevent the direct rays of the sun reaching the soil; (2) as a stimulant to an early or a very heavy crop; (3) as a protection to the surface roots of tender subjects during the colder months of the year. As to the proper time to apply mulches one must be guided by the weather and the locality. The best time is after the soil is warmed by the sun's rays, but before the sun has drawn all the moisture from the surface. It must be remembered that the roots of plants and trees need air and warmth, therefore in the first place the mulching material should not consist of wet, heavy

manure, which tends to prevent the air and warmth from reaching the roots. Where it is intended to stimulate the crop a good mulch of horse droppings is very beneficial, or, if manure from the cowsheds be preferred, a good quantity of short, rotten, strawy litter should be mixed with the same, to prevent it settling too closely. If mulches are only intended to check evaporation of soil moisture, either lawn mowings, old mushroom-bed materials, moss litter, or leaf mould may all be used to advantage. Frequent hoeing is also a means of checking evaporation, but one that cannot always be carried out, especially when labour is scarce. In the case of mulches used for stimulating and forwarding early crops, the application had better be a little late rather than too soon, for if warmth and air are prevented from reaching the soil and roots in early spring the result will be that the crop will be later than if the mulch had not been used. When mulches are employed to give warmth and protection (as in the case of a winter mulch) the nature of the manure must be considered, for if frost, cold winds, and wet are to be guarded against, the material must be such as will dry quickly, and can be easily packed about the bottom part of the stems.—The Gardeners' Chronicle.

CONTINUOUS DRY LAND CULTIVATION.

Much has been said and written in condemnation of the practice of the method of cultivation in vogue in some parts (chiefly the dry districts) of Ceylon where the available area of cultivable land is disproportionately large in comparison to the population. This method consists in cultivating land for a year or two, then abandoning it and moving on to a fresh area.

There are those who hold that so long as the supply meets the demand made under such a system, there is no reason for condemning it. Be that as it may, a time is bound to come with the increase of population when more up-to-date methods will have to be adopted and the sooner this fact is realised and the principles of conserving the fertility of the soil understood, the better for the cultivator and the country at large.

The necessity of rotating annual crops, that is growing a variety of crops in succession, cannot be sufficiently impressed upon our cultivators. If the same crops be grown continuously on the same land, there is greater tendency to exhaustion of the soil than if it is grown in a rotation. The reason why there is less exhaustion in the latter case is that some crops take up more of one kind of food than another. Again, some crops are shallow-rooted, others are deep-rooted, and plant food is thus drawn from varying depths of soil when different crops follow one another. Lastly, there are some crops which exert a special fertilizing action on the soil that others cannot do and these must, whenever possible, be included in a rotation. This fertilizing property is possessed by leguminous or bean-bearing crops.

It would be very difficult to induce cultivators to adopt rotation of crops as it is generally understood and practised in England and other countries in view of the fact that dry-land cultivation of annual crops is carried on on a small scale, i.e., by individual cultivators who seldom cultivate more than an acre of land which they generally sow with a mixture of seeds, consisting of one main crop (such as kurakkan) and such subsidiary crops, e.g. Indian corn, Amaranthus, Mustard, etc. It will thus be seen that the cultivator must have his supply of cereal grain (generally millet) to serve for food, and it is therefore necessary to modify the commonly accepted idea of a rotation, viz., giving up the land to one crop one year and a different crop the next. Taking for instance a two course rotation the simplest modification to meet the case would be to divide the available land into two (preferably

equal) parts and in the same season cultivate one part with a cereal and the other with a leguminous crop. Similarly for a three course rotation the land would have to be divided into three parts and cultivated with a cereal, legume and root crop ; and so on.

The cereal may be hill paddy, maize, sorghum, or one or other of the millets (species of Paspalum, Setari, etc.) ; the legume species of Phaseolus. Vigna, Cicer, Cajanus, or Arachis, etc., the root crop Cassava, Sweet-potato, etc.

In suitable areas cotton might be introduced as a fourth crop, and where preferable an oil-producing crop such as Sesamum takes its place.

In the three courses referred to the arrangement would be as follows :—

A.—1st year	cereal	legume	cereal	
2nd ,,	legume	cereal	legume	
B.—1st year	cereal	roots	legume	
2nd ,,	roots	legume	cereal	
3rd ,,	legume	cereal	roots	
C.—1st year	cereal	roots	cotton	legume
2nd ,,	roots	cotton	legume	cereal
3rd ,,	cotton	legume	cereal	roots
4th ,,	legume	cereal	roots	cotton

In the case of some shortlived varieties it would be possible to get two crops in the season.

In addition to this a modified rotation there are other points which call for attention in the adoption of up-to-date principles of cultivation, viz., proper preparation of land, regular sowing, tillage and weeding, and manuring.

In preparing the land for cultivation it should be dug or ploughed to a proper depth, cleared of stones and weeds, pulverised and levelled.

Sowing should be done in rows, at suitable distances in the rows and between them, so as to give the plants the best scope for securing food and moisture, light and air, and allow of weeding and tilling.

By tillage is meant intercultivation which keeps the soil loose and aerated, conserves soil moisture, keeps out weeds, and helps the roots to grow and feed. By keeping out weeds the general sanitation of the soil (in relation to insects and pests) is satisfactorily maintained.

Lastly there is manuring. Where cattle manure is difficult and folding cattle on the land (so much practised in the North) is not possible the practice of green manuring should be followed. This can best be done by raising a green crop, preferably of a leguminous kind (such as Grotalaria, Sesbanea) in the off season to be worked into the soil and allowed to decompose therein, so adding humus and supplying nitrogen as well as a certain proportion of mineral matter to the soil, improving its texture and increasing its capacity for retaining moisture.

Another method is to dress the land with green stuff collected from outside and brought on to it, as is done in the Jaffna peninsula, where Tephrosia, Adhatoda, Croton, etc., are largely employed for the purpose of adding fertility to the soil.

The Society has for some years endeavoured to demonstrate the advantages of such approved practices at the gardens in charge of Agricultural Instructors, whose work in this connection has given encouraging results, though it will be some time yet before the practice is likely to become common.

C. D.

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